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CHLAMYDIA AMONG YOUTH IN STOCKHOLM; TESTING HABITS AND EVALUATION OF A MOBILE PHONE INTERVENTION TO PROMOTE SAFE SEXUAL PRACTICES

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CHLAMYDIA AMONG YOUTH IN STOCKHOLM; TESTING HABITS AND EVALUATION OF A MOBILE PHONE INTERVENTION TO PROMOTE SAFE SEXUAL PRACTICES

THESIS FOR DOCTORAL DEGREE (Ph.D.)

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ABSTRACT

Background

The World Health Organization (WHO) estimates that 350 million new cases of curable sexually transmitted infections (STIs) occur each year. Prevention of STIs include both primary and secondary prevention strategies: sexual education, condom distribution, testing and treatment services. Sweden has a long tradition of widespread testing for Chlamydia Trachomatis (*C.trachomatis*), an opportunistic screening approach. Sexual education in school is mandatory and a national network of Youth Health Clinics (YHC) enables health care access for youth. Still, infection rates of *C.trachomatis* have increased over the past decades since opportunistic screening was introduced, and moreover continue to stay high. In addition, national surveys indicate low condom use among youth.

The overall aim of this thesis was to look deeper into the screening services to understand why this approach does not seem to have the sought for effect and to compare the effectiveness of a mobile phone application to improve sexual health among youth of Stockholm County in addition to routine care offered at the YHCs.

Methods and Results

Study I: Register based study performed from data obtained from three laboratories in Stockholm County. All tests for *C.trachomatis* done at the YHCs in Stockholm over a three year period were included in the study. The aim of the study was to describe testing behavior for genital *C.trachomatis* among youth in Stockholm County. Specifically to (1) study positivity rates among single and repeat testers, (2) to estimate the incidence of repeat testing and the rates of infection on repeat testing episodes and (3) to estimate time to repeat testing and factors associated with repeat testing. In total 65 951 persons underwent 119 699 tests. Repeat testing was found among 42% of all study participants included in the study (ranging from 2 to 18 tests). Higher rates of *C.trachomatis* among repeat testers compared to single testers were found at baseline, especially among men. Incidence of repeat testing was higher than previously reported.

Study II: A qualitative study. We interviewed 15 repeat testers at the YHCs about motives behind testing repeatedly and subsequent sexual risk-taking. Data was analyzed using a constructivist grounded theory approach. We found that youth perceive repeated testing for *C.trachomatis* equally protective as

using a condom. The testing episode, test result or encounter with the clinic personnel did not steer sexual health preferences towards more protective sexual practices. A major motivation for the retesting process was the fear of infecting a peer leading to social stigma. The results of this study provide new information that will allow the *C.trachomatis* screening programs to introduce more appropriate interventions for youth retesting frequently and to streamline routines. In addition, lessons learned from our study could be helpful in other screening programs with high re-testing rates.

Study III: Interview study. Twelve health care providers in YHCs in Stockholm were interviewed to explore their views on the practice of youth repeatedly testing for *C.trachomatis* 'to stay safe and clean'. A content analysis approach was used to analyze data. Health care providers' expressed appreciation for the easy-access testing services, as it facilitated individual sexual health counselling. Testing without having time to interact and reflect together with the youth was not perceived as meaningful. Findings from this study could strengthen ongoing preventive work thus involving the experience and expertise of daily care youth health care provider's.

Study IV: Randomized controlled trial (RCT). We aimed to complement and strengthen primary prevention strategies using a mobile phone intervention, (mHealth) given their popularity with youth. Following focus group discussions with young people, we developed a youth friendly smart phone application. The aim was to increase condom use and promote safe sex. The effect of the intervention was evaluated in a two arm parallel group pragmatic RCT; "The MOSEXY trial" (MObile Phone intervention for SEXual health in Youth). At time of inclusion, consistent condom use was reported by 1/10 of participants. Condom use increased in both arms however with no differences between the groups. In addition, number of sexual partners, frequency of re-testing and occurrence of STIs did not differ among the groups.

Conclusion

On an individual level, easy and prompt access to testing services is important in order to interrupt transmission of STIs and treat infections. At the same time secondary prevention strategies must not undermine primary prevention strategies aiming to improve sexual health in means of avoiding infections by condom use. A mHealth intervention did not increase condom use among youth in our setting. However, mHealth for sexual health has the potential to reach large group of youth effectively.

LIST OF SCIENTIFIC PAPERS

I. ***Chlamydia trachomatis among youth - testing behaviour and incidence of repeat testing in Stockholm County, Sweden 2010-2012***
Anna Nielsen, Gaetano Marrone, Ayesha De Costa
PLoS One. 2016 Sep 27;11(9):e0163597.

II. ***Repeat testing for Chlamydia trachomatis, a "safe approach" to unsafe sex? A qualitative exploration among youth in Stockholm***
Anna Nielsen, Ayesha De Costa, Kristina Gemzell Danielsson, Mariano Salazar
BMC Health Serv Res. 2017 Nov 15;17(1):730.

III. ***"Repeat testing without having the talk is not meaningful" Health care providers' perceptions on finding a balance between Chlamydia trachomatis testing and primary prevention strategies. A qualitative study***
Anna Nielsen, Ayesha De Costa, Kristina Gemzell Danielsson, Jens Boman, Mariano Salazar
Submitted for publication

IV. ***The MOSEXY Trial – Mobiel Phone intervention for Sexual Health in Youth. A pragmatic randomized controlled trial to eveluate the effect of a smart phone application on sexual health in youth in Stockholm, Sweden***
Anna Nielsen, Ayesha De Costa, Kristina Gemzell Danielsson, Jens Boman, Gaetano Marrone, Mariano Salazar, Vinod Diwan
Submitted for publication

CONTENTS

LIST OF ABBREVIATIONS

AIDS	Acquired Immunodeficiency Syndrome
App	Application (to smart phone)
CONSORT	Consolidated Standards of Reporting Trials
C.trachomatis	Chlamydia trachomatis
CI	Confidence Interval
ECDC	European Center for Communicable Diseases
FGD	Focus Group Discussions
HIV	Human Immunodeficiency Virus
HPV	Human Papilloma Virus
IBM	Integrated Behavioral Model
ISRCT	International Standard Randomized Controlled Trials
ITT	Intention to Treat
LOCF	Last Observation Carried Forward
mHealth	Mobile phone based health care support
MI	Motivational Interviewing
MSM	Men who have sex with men
OR	Odds Ratio
PID	Pelvic Inflammatory Disease
PIN	Personal Identification Number
PRECIS	Pragmatic Explanatory Continuum Indicator Summary
RCT	Randomized Controlled Trial
SCB	Public Authority of Statistics Sweden
SMS	Short Messaging Services
STD	Sexually Transmitted Disease
STI	Sexually Transmitted Infection
TTM	Trans-Theoretical Model
UK	United Kingdom
US	United States
WHO	World Health Organization
YHC	Youth Health Clinic

1. BACKGROUND

1.1 SEXUAL HEALTH

"Sexual health is a state of physical, emotional, mental and social well-being in relation to sexuality; it is not merely the absence of disease, dysfunction or infirmity. Sexual health requires a positive and respectful approach to sexuality and sexual relationships, as well as the possibility of having pleasurable and safe sexual experiences, free of coercion, discrimination and violence. For sexual health to be attained and maintained, the sexual rights of all persons must be respected, protected and fulfilled." (World Health Organization, WHO[1]).

Sexual health is a broad and sometimes complex concept that spans over a lifetime of different needs, wishes, joy, disappointments, and risks. Among many things, sexual health depends on the individuals' access to sexual health information and education, knowledge about risks, susceptibility to risk-taking consequences, and access to sexual health care services.[2]

The focus of this thesis is sexual health in relation to sexually transmitted infections (STIs), and sexual risk-taking defined as behavior that increases the risk of contracting a STI among the youth population.

1.2 SEXUALLY TRANSMITTED INFECTIONS

1.2.1 Historical context: sexually transmitted infections and barrier protection

Interpretations assert that STI epidemics are described already in the Old Testament. In ancient time, STIs were considered a punishment for inappropriate behavior or consequence of bad personal hygiene. Further evidence in literature originates from ancient Rome and Greece, and the medieval ages up until 15th century. Throughout this time period, STIs were not fully understood in terms of source of infections and infectivity, although theories of STIs relationship to sexual activity were emerging. Different symptoms were interpreted as variations and different stages of the same disease.

During the 15th and 16th centuries, a "new disease", imported by Columbus, with severe symptoms spread quickly over Europe (syphilis), affecting people regardless of social status. Irrespectively excising taboos, sexual activity and prevention measures were discussed. Misinterpretations and misconceptions gave rise to many theories regarding STIs over the coming centuries. It was not until the achievements in microbiology in the late 19th and early 20th century that these misconceptions could be rejected.[3]

Condom is a barrier method that can prevent unwanted pregnancy and STIs. Since ancient Egyptian times, penis protection has been used for the purpose of non-fertilization. Various materials were applied throughout history to attain the desired effect, such as linen, silk, and animal intestinal devices. In the 16th century, the Italian doctor, Gabriel Fallopius, described how men can protect themselves from venereal diseases by wrapping linen, preferable soaked in saliva, around their penises. It has further been described that he tested "the condom" in 1100 men, of whom none contracted syphilis. At the end of the 19th century, condoms of raw rubber were manufactured, and when large-scale production of thin latex was possible the 1930s, the condom became increasingly popular.[4 5]

Figure 1. History of the condom (Image source: *Historical Museum at Lund University, Sexinfo-online University of California,*[4] *permissions obtained)*

1.2.2 The global burden of STIs

STIs, also referred to as sexually transmitted diseases (STDs), are transmitted from one person to another through sexual contact, and are caused by bacteria, viruses or parasites. Mother to child- and blood transmission, are other routes of STI transmission. STIs primary affects the genitals, the reproductive tract, the urinary tract, the oral cavity, and/or the rectum.[6]

STIs are caused by more than 30 different pathogens among which eight are most prevalent worldwide. These are: Hepatitis B, Human Immunodeficiency Virus (HIV), herpes, Human Papilloma Virus (HPV) which are viral STIs, and chlamydia, gonorrhea, syphilis, trichomonas which are non-viral and curable STIs. Globally, more than 400 million people carry genital herpes, and more than 290 million women have an HPV infection. WHO estimates that 350 million new cases of curable STIs (chlamydia, gonorrhea, syphilis and trichomonas) occur each year.[6]

Given the magnitude, the burden of STIs is borne at all societal levels. At individual level, STIs can cause mortality and morbidity, besides social stigma. Individual-based interventions aim to reduce morbidity/mortality and improve management through counselling, distribution of condoms, tests, vaccines, and treatment. Partner centered interventions aim to reduce transmission through partner notification and partner treatment. At a population level, interventions should aim to prevent or mitigate an epidemic through primary prevention programs, population screening, and vaccination programs. STI related interventions are widely described however, despite this, not available to everyone globally.[7] The setting of this thesis is a high income country where STI prevention strategies are available at individual-, partner-, and population level.

1.2.3 Chlamydia Trachomatis: situational analyses globally and in Sweden

Genital Chlamydia trachomatis (*C.trachomatis*) is the most commonly reported STI worldwide and is considered a major public health problem.[6] *C.trachomatis* can cause severe subsequent complications including pelvic inflammatory disease (PID), which in turn can lead to tubal factor infertility, ectopic pregnancy, preterm birth and recurrent spontaneous abortions (Figure 2).[8-10] In addition, *C.trachomatis* increases susceptibility to HIV infection.[11 12] *C.trachomatis* can ascend to the upper genital tract in men, complications for women are more common and more severe.[13]

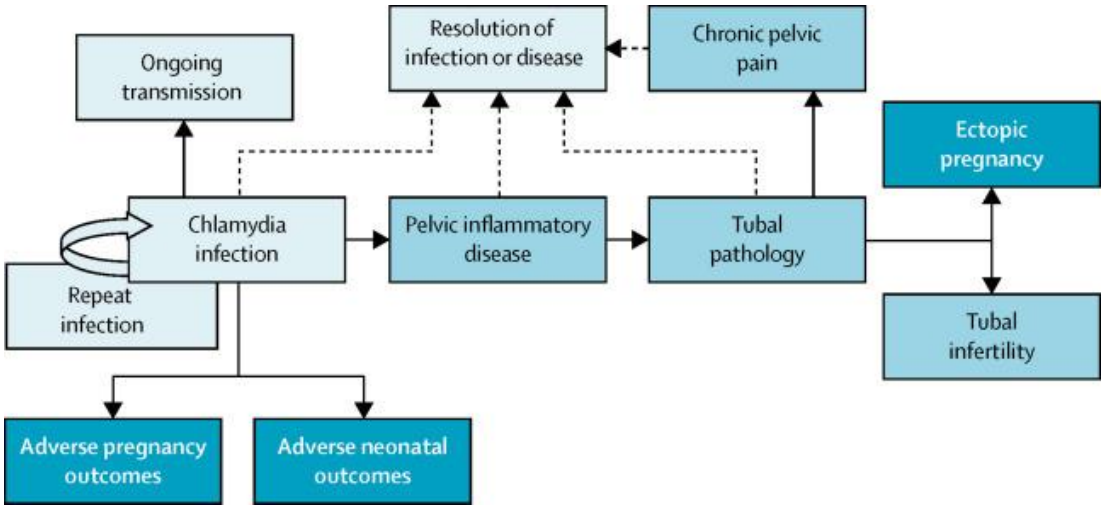

Figure 2. Histology and possible health complications of *C.trachomatis* (Image source: *STI: challenges ahead, Lancet, 2017*[14] *and European Centre for Disease Prevention and Control. Guidance on chlamydia control in Europe – 2015. Stockholm: ECDC; 2016*[15]*, permissions obtained).*

Symptoms for women might include increased or altered vaginal discharge, bleeding between periods or after intercourse, burning sensation/pain during urination, and/or lower abdominal pain.[16] Men might experience discharge from the urethra, burning sensation/pain during urination and/or pain in the testis.[17] Most cases (up to 80%) of *C.trachomatis* remain asymptomatic.[18 19]

Women account for the majority of reported infections. Approximately 57% of all cases in Sweden, and in Europe, are in women,[20 21] while the corresponding figure for the US is 66%.[22] In 80% of all reported cases heterosexual transmission is reported.[20 21]

An objective comparison of *C.trachomatis* incidence between countries is difficult as reporting practices and national screening practices vary widely.[15] In the US, 528 cases per 100 000 population were reported in 2017,[22] in Australia the corresponding number was 379/100 000 (2017).[23] Among European countries, who reported high figures in 2016 the UK had 350/100 000 cases, Sweden 337, Norway 478, Denmark 573, and Iceland 650/100 000.[21]

Prevalence point estimates from population based studies vary largely depending on country, age group, sex, population coverage and risk-group. In population-based surveys among sexually active youth ≤ 26 years old, *C.trachomatis* prevalence range from 3.0% to 5.3% for women, and from 2.4% to 7.3% for men.[24] In Australia the estimated prevalence is 5.0%,[25] and a national based study from the

Netherlands estimated a prevalence of 2.8% (1.1% in men and 5.6% in women) in ages 18-34.[26] In 2012 the global prevalence was estimated to 4.2% in women and 2.7% in men.[27]

The incidence of genital *C.trachomatis* in Sweden is considered high. In 2018, there were 32006 new infections reported in the country. Since 1995 there has been a steep increase in *C.trachomatis* incidence, however it seems to now have stabilized at a high level. There has been a slight decrease in total number of reported cases over the past 3 years since this thesis work began (Figure 3) but the reason for this is not established.[20] While increasing rates of reported *C.trachomatis* cases can be attributed an actual increase in incidence and sexual risk-taking, more sensitive tests, and/or increased case finding practices,[28] the opposite could apply for the current stable/slightly decreasing rates of *C.trachomatis*.[21-23]

The increase in reported cases during 2007-2008 represent a mutated form of *C.trachomatis,* discovered first in 2006, but firstly detectable in laboratories the following years (Figure 3).[20] Of all tests in Sweden 6-7% were positive (2009-2018).[20] Calculated prevalence in STI clinical settings is reported at approximately 11 %.[29 30]

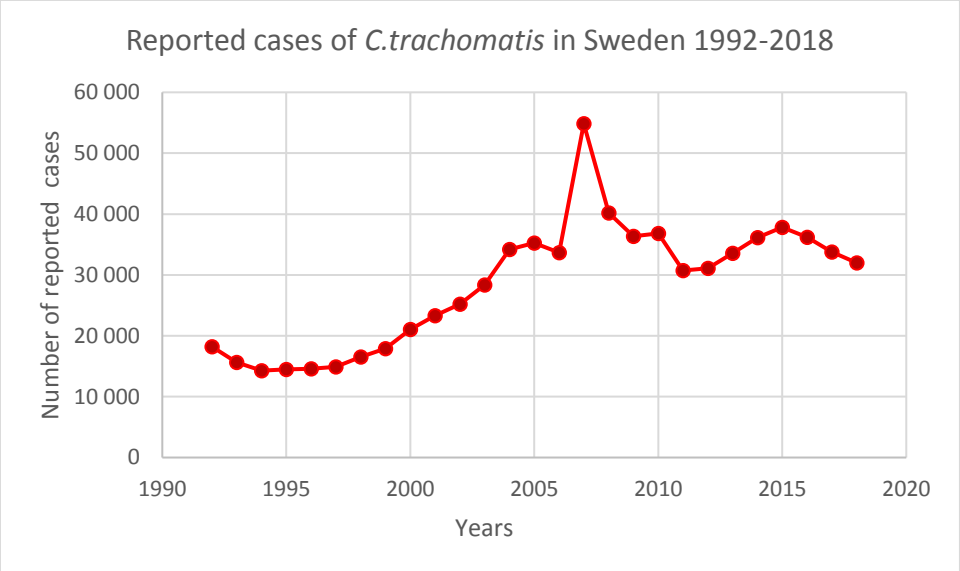

Figure 3: Number of reported cases of *C.trachomatis* in Sweden between 1992 and 2018.[20]

Globally, adolescents and young adults are disproportionally affected by *C.trachomatis*.[21] In Sweden, people aged 15-19 account for approximately 25% of all reported infections, people aged 20-29 account for approximately 60%, and for 30-39 year old 12% (Figure 4).[20] Young women represents a

higher proportion of *C.trachomatis* in the younger age groups, i.e. 15-19 and 20-24, whereas rates among men are higher for those age 25 and older.[21] In this thesis, we will focus on sexual health and *C.trachomatis,* which is often described as a marker for sexual risk taking,[31] and prevention among youth.

Youth are defined by the WHO as people aged 15-24.[32] This thesis was conducted at the Youth Health Clinics (YHCs) where people aged 12-23 are received.[33] Youth will here be referenced as a person visiting the YHCs for sexual health related issues, and while the mean age for first sexual intercourse in Sweden is 16 years,[34] our definition will imitate the WHO definition.

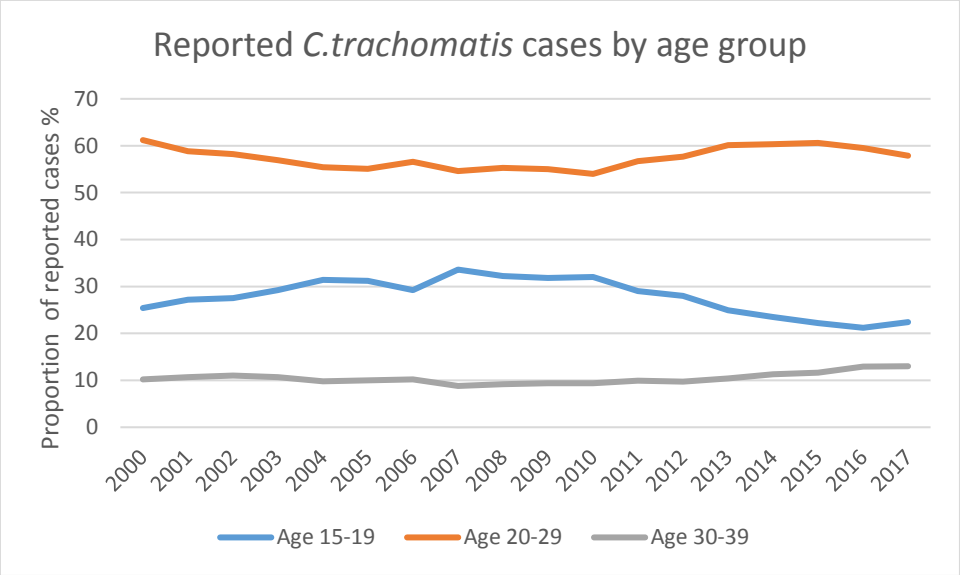

Figure 4. Proportion of reported *C.trachomatis* cases by age group.[20]

1.3 SEXUAL RISK-TAKING

1.3.1 Sexual behavior of youth in Sweden

Risky sexual behavior includes sexual activity at an early age, having multiple sexual partners, concurrent partners, having sex while under the influence of alcohol or drugs, and unprotected sex (i.e. without condom or other contraceptives) with a new of temporary partner.[35-38] Predictors of sexual risk-taking have been widely studied and both individual- and family determinants have been described.[39] At an individual level, younger age at sexual debut predicted sexual risk-taking, at family level growing up with a single parent predicted early sexual debut.[39] Specific predictors of *C.trachomatis* acquisition for young women were number of partners and having been (financially) reimbursed for

sex. In men, the strongest predictors were number of partners and level of alcohol consumption.[37] Additionally, *C.trachomatis* infections has also been associated with social-economic disadvantages, and belonging to minority ethnic groups.[40 41]

Young people's sexual habits have repeatedly been explored in Swedish surveys and studies.[42 34 43] Sexual risk-taking among youth in terms of having multiple sexual partners and a more liberal view on sex outside a stable relationship, has significantly increased over the last decades.[44 45 46] More so, people have children later in life, thus the period of exposure to sexual risks and sexual risk-taking has increased.[47]

Although knowledge and confidence in condoms as an effective way of preventing STIs has increased, this has not resulted in more widespread use.[34 42 48] In a large national population based study (2007) involving 20 000 men and women aged 18-30, 50% of women and 40% of men, stated that they never or seldom used condoms with a temporary partner.[49] A national survey among youth aged 15-29 (UngKAB09, 2009) reported 70% frequency of not using a condom at the last intercourse, and 50% said they did not use a condom with a new partner at the last intercourse.[42] When the study was partly replicated six years later (UngKAB15, 2015), 25% stated that they used a condom continuously during their latest intercourse, however this result included all participants, not only those with a new or temporary partner at last sexual encounter.[34] Although the proportion of intercourses with a condom is considerably low, interestingly 89% of youth stated that they would not have had any problems suggesting a condom at their last intercourse.[34]

Regardless of the high proportion of non-condom users, the percentage of youth who perceive themselves at risk of STIs is low. In a study among sexually active youth aged 15-24, 46% stated they were at no risk of an STI whereas 31% said they perceived a little risk being infected by a STI.[43] In a population based study including those without sexual experience, 71% perceived themselves at little or no risk of contracting STI.[42]

In general youth are much more worried about unwanted pregnancy than STIs.[43] Approximately 60 % of young women aged 15-24 declared that they were using contraceptives (most commonly contraceptive pills) other than a condom at their last intercourse. Six percent, used a condom in combination with another contraceptive method .[43] Increased use of non-condom anticonception over

the past years[43] is indeed encouraging, however from the perspective of STI reduction, dual protection, also referred to as the "double Dutch approach", i.e. combining contraceptives with condoms – is more appropriate.[50]

1.3.3 Condom use and condom failure

Failure to use condoms has been the focus of many studies. A condom can be considered embarrassing to mention, awkward to use, and costly.[51-54] Other important factors that affect condom use are: influence of alcohol or drugs, fear of losing erection; sensation reduction, a sense of 'will not happen to me' attitude, forgetfulness (easy to forget in the heat of the moment), interference with spontaneity, waiting for sexual partners to be "condom promoters", the use of other contraceptives, and peer habits and behaviors.[51-55] Young people also report not being prepared for the situation, i.e. they did not bring a condom while others report insecurity about how to use a condom.[43] Reasons for not using condoms are thus many and well known.

1.4 PREVENTION OF *C.TRACHOMATIS*

1.4.1 Primary prevention strategies for *C.trachomatis in Sweden*

Primary prevention strategies include activities aimed at preventing new cases through health and sexual education, sex-health promotion campaigns as well as condom promotion and distribution (Figure 5). In Sweden, sexual education is part of the elementary school curriculum. From the age of 10 years, and throughout compulsory school, sexual education is embedded into different school subjects.[56] Additionally, the national Swedish network of YHCs plays an essential role in primary prevention strategies for STIs. Sexual health and personal development throughout the youth period is the main focus of the YHCs.[57] Despite school strategies, youth rates the internet as the first source of information regarding sexual health after friends and YHCs.[34]

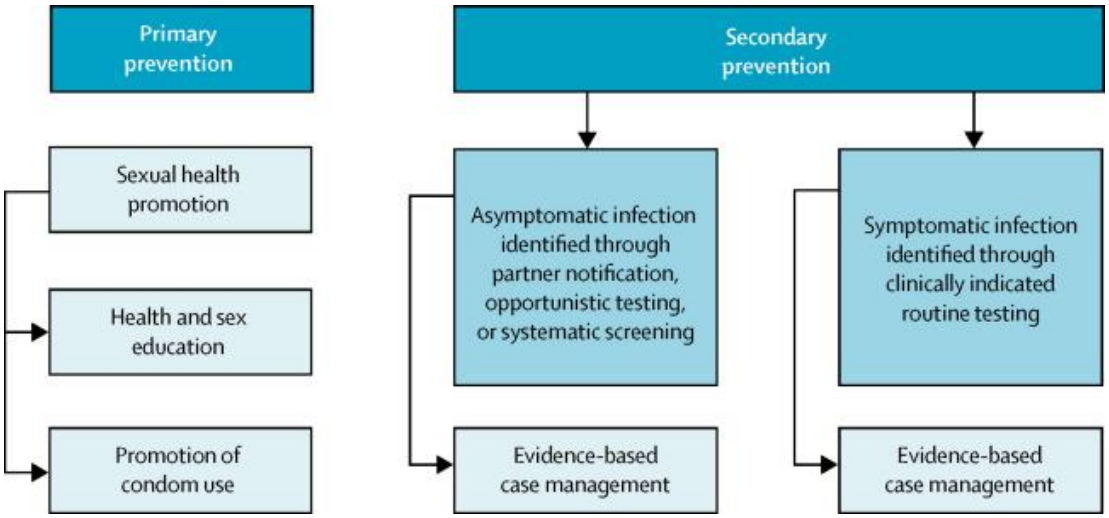

Figure 5. Primary and secondary prevention for *C.trachomatis* (Image source: (Image source: *STI: challenges ahead, Lancet, 2017*[14] *and European Centre for Disease Prevention and Control. Guidance on chlamydia control in Europe – 2015. Stockholm: ECDC; 2016*[15]*, permissions obtained).*

1.4.2 Secondary prevention strategies *C.trachomatis*

Secondary prevention of *C.trachomatis* aims to prevent transmission to a sexual partner and reduce risk of negative consequences of an infection by testing, treatment and partner notification (Figure 5). There are large differences in *C.trachomatis* control policies across Europe and worldwide. The guidance for Chlamydia Control published by the European Center for Disease Prevention and Control (ECDC) aims to support member states to implement and/or improve national strategies for *C.trachomatis* built on the capacity of the different national health care systems.[15]

Across Europe the organization of *C.trachomatis* control range from being nonexistent to large population screening programs.[58] National screening is available only in one country in Europe, the UK.[59] The opportunistic screening approach includes case finding (including contact tracing) and offering testing to one/more than one specific group of asymptomatic people (e.g. pregnant women or youth) (Table 1).[15] Over the past decade, *C.trachomatis* control activities has strengthened in Europe and most countries report primary prevention activities in addition to case management guidelines and partner notification (Category 3, Table 1).[60]

Table 1: Categories of *C.trachomatis* control activities in Europe (ECDC[61])

Category		Criteria
1.	No organized control activity	No national guidelines for *C.trachomatis* diagnosis and treatment
2.	Case management	Guidance on *C.trachomatis* diagnosis/treatment to at least 1 group of health care professions
3.	Case finding	Case management guidelines and partner notification
4.	Opportunistic screening	Case finding and testing offered to at least one group of asymptomatic people.
5.	Screening programs	Organized *C.trachomatis* screening to a substantial part of the populations

1.4.3 Opportunistic screening for *C.trachomatis* in Sweden

Guided by national laws and regulations,[62 63] regional policies control the preventive work in the different County Councils in Sweden.[64] Sweden has a long tradition of widespread testing. An opportunistic screening approach was introduced already in 1982 offering *C.trachomatis* testing to women requesting contraceptives, antenatal care or abortion Male partners of infected women were also tested thru contact tracing.[65 66] In the late 80s the infectious disease law was changed and came to include free testing and treatment of *C.trachomatis*, partner notification and case reporting.[63]

The number of reported cases of *C.trachomatis* decreased in Sweden up to the mid-1990s (Figure 3).[65-67] However, the decline during this period also coincided with the national HIV prevention campaigns.[68] Despite this initial positive effect of widespread testing, and national efforts as availability of testing and treatment services, the number of reported *C.trachomatis* cases in Sweden has, over the past two decades, steadily increased and has now stabilized at a high level.[20] Nevertheless the Swedish opportunistic screening program including availability of widespread testing to asymptomatic persons, the infectious disease law which enabled free testing and treatment and partner notification, has been held up as an example of success in relation to *C.trachomatis* control.[69]

1.4.4 The effectiveness of screening for *C.trachomatis* on prevalence and sequelae

Screening for *C.trachomatis* aims at controlling the transmission, reducing infection prevalence, and thereby reducing the risk of severe reproductive complications such as PID and tubal factor infertility

(Figure 2).[59] Numerous studies as well as policy documents conclude that increased testing coverage and re-testing is important to halt the *C.trachomatis* epidemic.[70-73] However, while more and more countries introduce different levels of *C.trachomatis* control strategies and screening programs there is an ongoing debate about the benefits of such programs, [13 69 74 75] both regarding cost-effectiveness,[19 76-78] and the fact that *C.trachomatis* associated complications might be lower than previously expected.[75 79-82]

The Netherlands stopped a pilot national screening program in 2012 after a trial showing no statistical evidence of impact on *C.trachomatis* positivity rates or estimated population prevalence from the *C.trachomatis* Screening Implementation programme.[83] Although difficult to compare, (due to different methodologies), in the UK population based prevalence has not changed between 1999-2000 and 2010-2012, i.e. before and after the rollout of the national screening program.[84] More so, national representative studies on *C.trachomatis* prevalence, indicate no differences between countries with screening programs and those without.[40 84-90] Hence, the evidence of the impact of opportunistic screening and screening programs is limited and there is no conclusive evidence of the impact of such programs in reducing infection of *C.trachomatis* at a population level.[61 83 84]

While it is clear that the incidence of PID in the population has decreased during the last 20-35 years it is not possible to determine to what level this was an effect of scaling up *C.trachomatis* prevention programs.[78] In fact, PID has generally decreased in a variation of countries, regardless if widespread testing /screening is present or not.[14] No long-term effects of intensified screening were found in terms of reduced reproductive consequences from a 9 year follow up Danish study.[82]

A recently published Dutch study found considerably higher risk for both PID and tubal factor infertility among women who previously experienced *C.trachomatis*.[91] Nevertheless, the overall incident of sequelae was low, only 1% of women experienced tubal factor infertility over an 8-year follow-up period. Given the low cumulative risk of sequelae, and the lack of evidence that screening affects prevalence, the authors suggests that focusing on women with risk of complications would be more feasible than widespread testing and screening.[91] Evidence to support a shift from focusing on screening to improved management of diagnosed cases and sequelae were previously presented.[14] For ectopic pregnancy, no elevated risk for those who previously experienced *C.trachomatis* was found.[91]

Despite the above, widespread testing, opportunistic screening and national screening are advocated as efficient methods to tackle the *C.trachomatis* epidemic.[38 70] Lack of beneficial evidence is said to derive from insufficient screening uptake in the populations, and outcome measure (prevalence) studied.[92] Mathematical models estimated that annual screening coverage of the target population of 30% or more, could decrease *C.trachomatis* prevalence.[93 94]

1.4.5 Population coverage: number of tests/tested persons and number of positive cases

Voluntary yearly reporting from the laboratories in Sweden to the Public Health Agency indicates an increase in number of tested persons/tests for *C.trachomatis* over the past two decades (Figure 6). Double reporting can possibly occur in the numbers reported from the laboratories.[20] Furthermore, some reports does not differentiate between persons tested and tests, i.e. ten tests can in fact constitute of less than ten unique individuals testing repeatedly over the year, and thus population coverage is hard to determine.

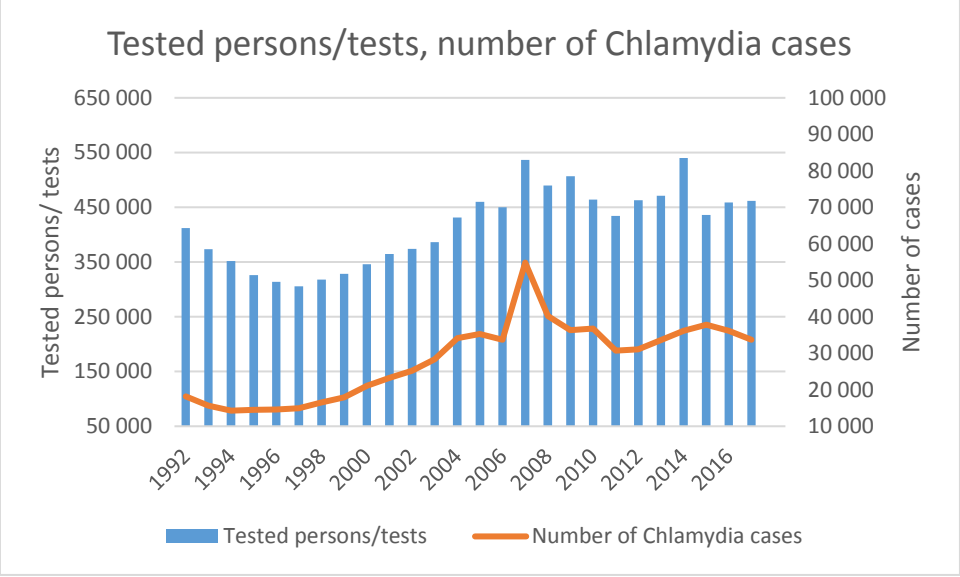

Figure 6: Number of tests/tested persons and number of positive Chlamydia cases. 1992-2017.[20]

The mandatory reporting of a positive *C.trachomatis* test in Sweden gives a close to accurate information about who is infected (i.e. age, sex, domestic or foreign source of infection and homo- or heterosexual transmission of infection).[63] The population coverage for testing and the frequency of re-testing is less studied. In a study conducted at a STI clinic in Stockholm, 82% of the clients (20-40 year old) reported having tested for *C.trachomatis* before, and 43% reported having been tested for *C.trachomatis* in the

previous 12 months.[29] This indicates that a significant proportion of tests are being done in the same persons. A study from New Zealand found that repeat testing was common and that estimates of population coverage by test overestimated individual coverage.[95] Similar finding were reported from the UK.[73]

1.4.6 Repeat testing related to risk of re-infection

Re-infection of *C.trachomatis* is common.[96] Re-infections has been described to increase the risk of severe consequences.[81 97] In different studies, approximately one of four women treated for *C.trachomatis,* were diagnosed again within one year.[98 99] Most re-infections origins from new infection with a new partner.[96] Recommendations to re-test within 3-6 months after an infection exists in some countries including US, Canada, UK, and New Zealand.[38 59 100 101] According to a mathematical model, a re-test within 2-5 months might be efficient in detecting new infections.[102] Annual screening for young people under the age of 25, is recommended in several countries including the US, Australia, Canada, and UK.[14 38 59 100] Sweden has no official policy for re-testing although The National Plan for Chlamydia Prevention (launched in 2009), recommended testing for those who exposed themselves to risk, and re-testing within six months for those with an elevated risk of *C.trachomatis.*[103]

1.4.7 Test and test results effect on sexual behavior

With an increasing number of *C.trachomatis* tests performed in Sweden, across Europe and elsewhere, it is important to understand if and how a test episode, and the test result affect the individual's future testing and sexual behavior. Approximately 450 000 tested persons/tests performed in Sweden per year (Figure 6) with an overall positivity rate of 6-7%, implies high numbers of negative test results.[20] In addition to clinical visits, on-line testing is increasingly popular.[104]

Existing evidence, although scarce, suggests that a positive test result of an STI might affect sexual risk taking towards a more protective attitude, at least in the short term.[105 106] Importantly negative STI test result on the other hand seems to have no effect on subsequent risk taking.[106] There are even studies that indicate that a negative test result has a negative effect on behavioral changes, i.e. adopting more risky sexual practices.[107-110] A phenomenon referred to as "unintended screening effect" has been described in the literature,[109] where a negative STI diagnosis is reported to result in creation of complacency about the importance of engaging in safer sexual practices. Similar findings were reported among young people in Sweden. Women described repeatedly testing for STIs to assure a disease-free

status. A negative test result did not change the women's behavior but rather confirmed to them that sex without a condom was not overly risky.[110] How a test episode, and the test result affect the individual's future testing and sexual behavior is studied in this thesis.

As described above, primary and secondary prevention should complement each other (Figure 5). However, it has been described that secondary prevention strategies tend to be prioritized over primary prevention.[111] Explanations for the focus on testing, treatment, and contact tracing could possibly be that such interventions are less time consuming, both for the health care providers and for the individual. Additionally, the effect of secondary prevention are easy to measure on an individual level, i.e. you are diagnosed and subsequently treated and cured. Furthermore, it might be perceived as easier to test than to change behavior (using a condom).

1.5 SEXUAL HEALTH INTERVENTIONS

It is indeed important that young people who expose themselves to risky sexual behavior test frequently. In addition to providing testing services, it is also desirable that caregivers uses the opportunity to guide testers towards a more protective behavior, i.e. primary prevention strategies. According to Swedish youth, approximately 50% who tested stated they had received primary prevention counselling.[34] It has also been reported that youth, testing for STIs, found talking about sexual practices in a face-to-face session with a caregiver, embarassing.[112]

Many studies have focused on finding and evaluating how to best tailor sexual health interventions.[107 113-117] Methods used, theoretical framework, and the effect of interventions vary.[118] Educational interventions has shown positive results in terms of increased knowledge regarding STIs, as well as attitude changes.[53] However, increased knowledge about STI does not necessarily translate into a positive impact on behavior (increased condom use, reduction in sexual partners).[119] School-based behavioral interventions tailored to improve and maintain safe sex behavior among youth showed improved knowledge and improved self-efficacy, however did not affect risk-taking or infection rate.[116]

During the last decade, sexual health interventions has focused on behavioral change interventions.[120] Motivational Interview (MI) to change sexual risk-taking was assessed in Sweden. Brief MI counseling significantly reduced the incidence of *C.trachomatis* and risky sexual behavior among women.[121] One

meta-analysis including over 50 000 patients showed a significant reduction of STIs in the group receiving single session behavioral intervention.[122] On the other hand, a systematic review was unable to detect strong evidence for the effectiveness of condom promotion interventions.[123]

In the WHO publication *"Brief sexuality-related communications: recommendations for public health approach"* (2015),[2] different behavioral change interventions were reviewed, and recommendations for promotion of sexual health using brief counselling were outlined. Most counselling interventions aimed to support young people to re-formulated emotions, their thoughts and eventually behavior by using a patient/client centered approach (for instance MI). In studies reviewed, it was found that brief counselling can improve consistent condom use,[113 124] increase sexual health knowledge,[125] and reduce STI prevalence.[126] Evaluated interventions involved both group counselling[127] and individual counselling, where individual counselling was found more efficient.[2] Single session interventions were found just as efficient as reoccurring sessions.[124-126]

A subsequent systematic review further explored brief counselling interventions with focus on the behavioral change techniques.[118] The most prevalent theoretical framework used were MI and *Information Motivation Behavioral Skills Model of Behavioral Change.* Among 85 reviewed studies, 53 were found efficient. In total, 48 different behavioral change techniques were identified including *problem solving, feed-back on behavior, and information about health-social-and- environmental consequences.* Hence, the authors conclude that a wide range of behavior change interventions can efficiently be used to tackle sexual risk-taking.[118]

1.6 MHEALTH TO IMPROVE SEXUAL HEALTH

It can be argued that scaling up of successful MI techniques and other forms of face-to-face counselling are time consuming, and may not be feasible for already time-constrained health care providers to implement. Thus, new innovative ideas to promote safe sex among youth are needed.

mHealth, an abbreviation for mobile health, is a term used to describe the practice of medicine and public health supported by mobile devices.[128] The use of mobile phone technology is an increasingly popular and relatively inexpensive way to reach large groups of the population to improve health

outcomes including sexual health, it can serve to complement ongoing activities within the health care system.[119 129-131 132]

mHealth interventions is particularly suitable for youth and sexual health promotion as the intervention is delivered in a familiar, and discrete way to at-risk population.[133] mHealth also offers the possibility of a range of different interventions for example reminder (to use a condom or to test), and motivational messages.[128] Furthermore the coverage of mobile phone ownership among young people in Stockholm County is high. Among the whole population in Sweden 97% own a mobile phone and the majority of these are smart phones.[134]

During the last decade youth targeted sexual mHealth interventions has been developed and evaluated.[130 135] Results from studies are diverse and somewhat conflicting. Using text-messages as a way to change behavior (in reducing the number of partners) were found effective in a randomized controlled trial in Australia.[136] STI prevention messages via Facebook, on the other hand, did not increase condom use over time, however prevented a decrease in condom use compared to the control group.[137]A systematic review found evidences that text message interventions increased adherence to antiretroviral medication in low-income.[138] Another systematic review of randomized controlled trials (RCTs), found that mHealth interventions for sexual health, increased knowledge regarding STIs, increased re-testing after *C.trachomatis* infection, and increased clinic attendance. The review comprised of ten RCTs, even though there were promising results, no significant changes in sexual risk behaviors, i.e. condom use was found.[128] A subsequent, more recent meta-analysis of mHealth interventions to reduce STIs, found a significant improvement of condom use, safe sex knowledge, and delay of sexual activity.[135]

Thus far, evaluations has foremost involved interventions delivered via e-mail, websites, social media, text messages to forward sexual and reproductive health information, and text-and voice message reminders.[128 135 139-143] A smart phone application (app) on a mobile device allows for more dynamic engagement and interaction between the user and the technology.[144 145]

Existing mobile phone apps for STI prevention and care were reviewed using app-store/google plays, showing that most available apps had failed to attract user attention.[145] This result emphasizes the need to involving targeted population in the development of the app. Except a qualitative evaluation of a

website for preconception health, [146] there has not been evidence from Sweden on the use of mHealth interventions to promote safe sexual practices among the youth. One of the studies in this thesis evaluates the use of a mHealth intervention on promoting safe sex among the youth.

1.7 THE IDEAS BEHIND THE ORIGIN OF THIS THESIS

This project is deeply rooted in the everyday clinical practice at the YHCs. In my role as a midwife at a centrally situated YHC in Stockholm, I meet 50 youth per week, the whole clinic receives approximately 6000 youth aged 12-23 each year. The causes of contact usually included contraceptive counselling, physical examinations, sexual health related counselling, and STI testing, treatment and contact tracing. Youth come for booked appointments (30-60 minutes), or drop-in appointments (10-15 minutes).

Informal discussion with colleagues regarding prevention strategies for STIs often took place during the coffee and lunch breaks. We experienced increasing demands from the health care system on accessibility and effectivity (meeting more youth) and we started to question the focus on secondary prevention strategies and whether these efforts would bring down *C.trachomatis* incidence. Reported high rates of *C.trachomatis* among our target group suggested efforts were not sufficient or needed to be re-focused. Additionally, when meeting youth who came to test, it occurred to me again and again that they seemed to be relying completely on the secondary prevention offered to them. Quotes like *"I test, therefore I am safe"* made me interested in the accessibility of testing services and how that might possible affect risk-taking.

I articulated a group of potential problems and research questions: What do we actually know about youth coming to the clinic? How often do they come? How often do they change clinics? How often do they test? How are they affected by the test result? Are our efforts to reach these youth with primary prevention strategies upon visiting the clinics doomed to fail?

Discussions continued among colleagues: if what we are doing today is not enough to affect sexual health among youth, then how can we strengthen our methods? It is my strong belief that all employees at the YHCs have a genuine wish to improve sexual health among youth, thus focusing on secondary preventions is not always satisfactory. However, with structural constraints within the health care

system, new innovating ways to promote preventive work seemed essential. Using mHealth for this purpose was discussed and perceived as feasible. mHealth offers the potential of delivering primary prevention information independent of health care providers available time.

Working with youth at the YHC, and in addition the many interesting and engaging discussions and debates with colleagues, inspired me and spurred the ideas which came about in this thesis.

1.8 THEROETICAL FRAMEWORK

1.8.1 Health care utilization model

The Andresen's Health Care Utilization Model, was chosen to conseptualize this thesis.[147] The adapted phase four model,[148] describes a number of interacting dynamics and areas influencing health service utilization (Figure 7). These are:

- **Environment** which includes the health care system (YHCs), mHealth services, and additionally sexual education in school.
- **Population characteristics** including the predisposing factors (sex, age, relationship status, and health beliefs) the enabling factors (support from peers/family, availability and accessibility to health care in the community), and needs (perceived and actual need to use health care services).
- **Health behavior** includes personal health practices such as safe or unsafe sexual practices, and use of the health care system for example STI testing and visits at the YHC.
- **Outcome** includes both objective health status (for example test result) and perceived health status (perceived risk and perceived severity of the possible outcomes, i.e. STI infection) but also "customer" satisfaction of the health care visit.

All four sub-studies move across these interacting areas. Study I specifically addresses the environment and the accessibility to health care in relation to testing services and additionally the population characteristics. Study II and III clearly refers to all above described dynamics by exploring the how accessibility to health care, and subsequently the outcomes affects health beliefs and health behavior.

In Study IV we explore the dimension of mHealth in relation to predisposing characteristics and the health behavior.

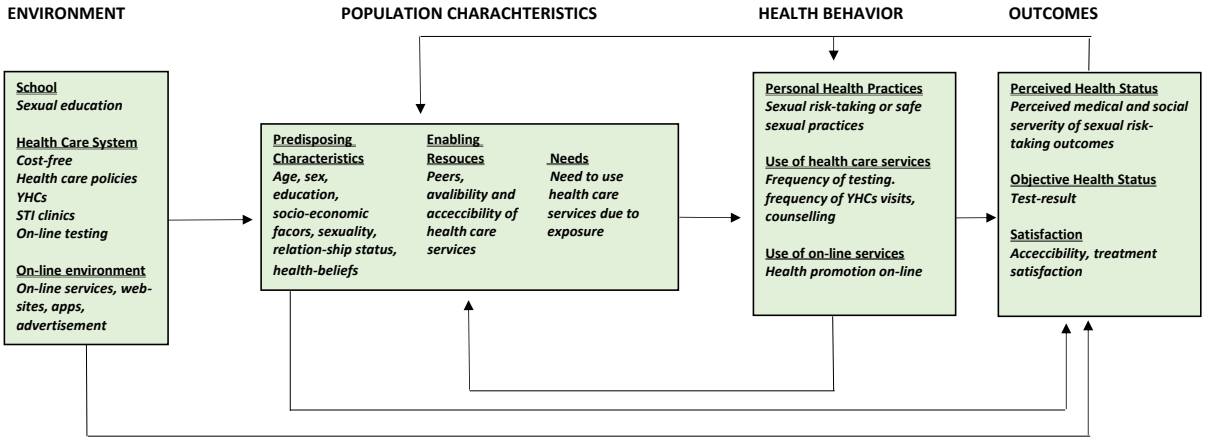

Figure 7. Health care utilization model (Figure adapted from Andersen Phase four model [148]).

1.9 SUMMARY

In summary; the best strategies to control *C.trachomatis* are yet to be defined.[6] Significant efforts to reduce *C.trachomatis* among youth has not resulted in sough after effect. Information on who is using the testing services and how frequently they do so, is essential to make correct assumptions regarding incidence, prevalence, and opportunistic screening coverage in the population. Furthermore, increased knowledge about who is using the testing services, the extent of re-testing, reasons for re-testing, and how test results impact on sexual risk-taking will have implications for planning and implementing interventions to lower the incidence of *C.trachomatis*. High rates of *C.trachomatis* among youth together with reports on low condom use, indicates that testing and treatment services need to be complemented with a stronger emphasis on safe sex. mHealth interventions targeted to youth could potentially promote sexual health and needs exploration in Sweden.

2. AIMS

The aim of this thesis was to study the testing behavior for *C. Trachomatis* at the Youth Health Clinics in Stockholm County and to evaluate a mHealth intervention to support safe sexual practices among youth. With regard to testing behavior, this thesis focuses specifically on the testing episodes and test results influence on future testing behavior and sexual risk taking. It further explores this qualitatively with youth and health care providers at Youth Health Clinics.

Specific aims were

To describe the testing behavior for genital *C.trachomatis* among youth in Stockholm County, with a focus on repeated testing.

To explore the motives for repeat testing for *C.trachomatis* among youth, and how testing affects subsequent sexual risk-taking

To explore health care providers' perception of youth testing repeatedly for *C.trachomatis* in Stockholm County

To evaluate the effects of a mobile phone intervention (mHealth) designed to promote safe sexual practices and improve condom use among sexually active youth in Stockholm County.

3. METHODS

3.1 STUDY SETTING

3.1.1 Stockholm County

The setting of the studies were the YHCs in Stockholm County, Sweden. Stockholm County is divided into 26 municipalities, rural and urban, and spread over an area of 6526 km^2.[149] (Figure 8.) The total population is 2 303 417 (2017), and youth aged 12-23 account for 13.2 % (303 595) of the population.[150]

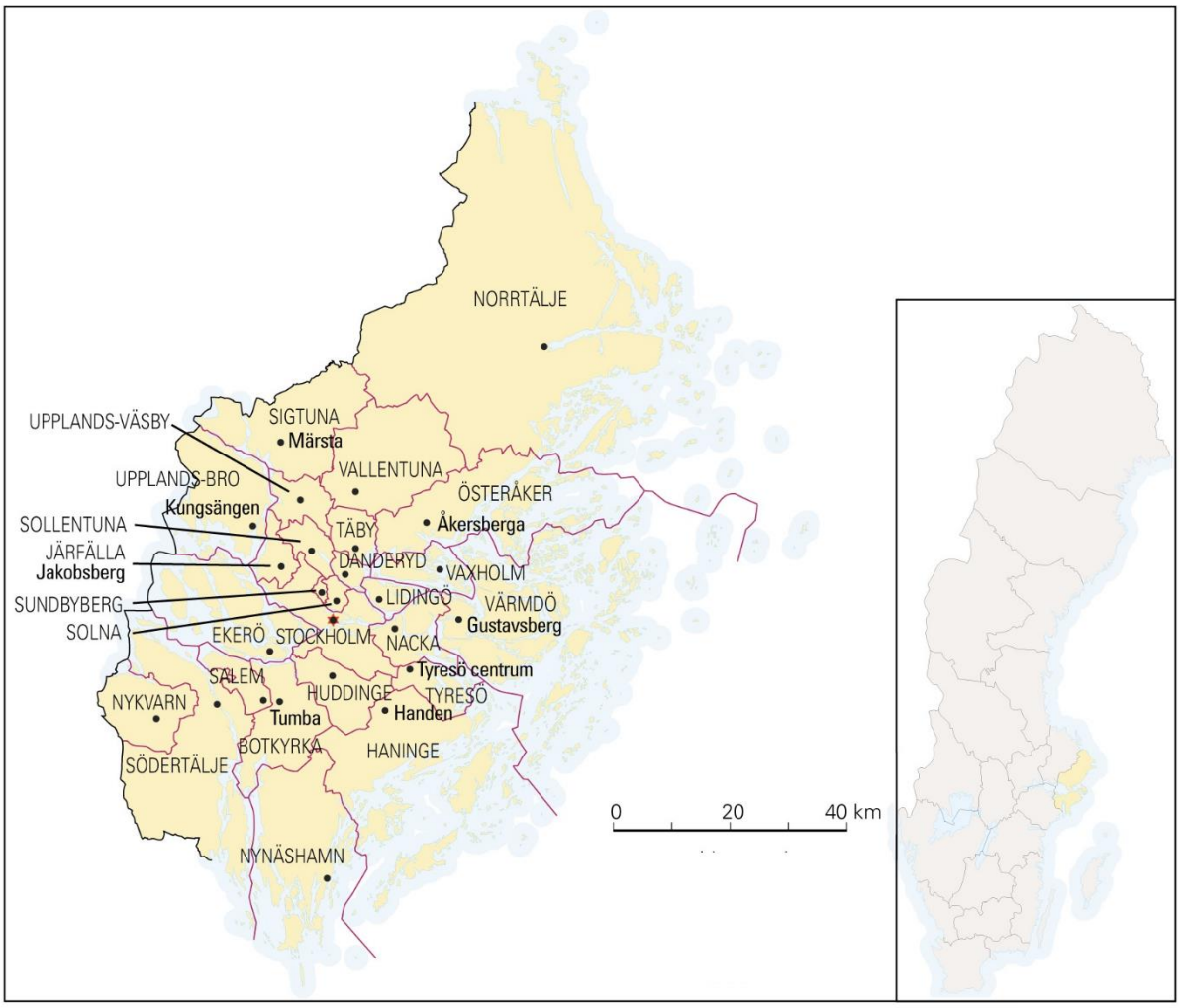

Figure 8. Stockholm County, 26 municipalities, location in Sweden (Image Source: *National encyclopaedia*[149])

3.1.2 Youth Health Clinics

The first YHC was launched in the 70:s Borlänge, Dalarna,[57] and the Association of Swedish YHCs was founded in 1988. Health care for young people is provided free of charge to the user in Sweden. This includes services accessed at the YHCs.[151] The national association of YHCs comprises approximately 220 clinics, and in Stockholm County there are 33 YHCs.[33 152] The last available report from YHCs in Stockholm County (2014), indicates 113000 annual visits were made by approximately 56000 unique visitors.[33] The 33 YHCs in Stockholm are situated in different districts and/or municipalities. Youth can access any preferred YHC.

Historically, due to increasing abortion rates, the clinics were focused on preventive work related to unwanted pregnancies, and abortion consultation. The AIDS epidemic in the mid-80s led to an increased focus on primary and secondary prevention of STIs. This included sexual education to individuals and groups such as school classes, condom information and distribution, as well as testing and treatment services.[57 149 152]

The YHCs receives youth ages 12 to 23. Apart from focus on sexual health and relationship related issues, the YHCs also provides individual and group guidance/counselling regarding lifestyle, personal development, mental health, and social problems. The YHC staff constitutes of nurse/midwives, behavioral therapists, social workers and physicians.

3.1.3 *C.trachomatis* in Stockholm County

The highest infection rate of *C.trachomatis* in Sweden is reported from Stockholm County with an incidence rate of 383 cases/100 000 inhabitants. In total, 8847 cases of *C.trachomatis* were reported to the authorities in 2018.[20] Heterosexual transmission is the most common way of contagion (88%), and more than half (53%) of reported cases appears in females.[153] In the country, 80% of all cases are found in aged 15-29.[20] Overall approximately 140 000 of all tests for *C.trachomatis* are annually done in the County,[153] and 40000 of these come from the YHC in Stockholm.[154] Of all positive tests in Stockholm 40% are reported from the YHC.[153]

3.2 STUDY OVERVIEW

The thesis comprises four studies and includes both quantitative (Study I and IV) and qualitative approaches (Study II and III). An overview of the methodology of the four studies is presented in Table 2.

Table 2. Overview of methodology study I-IV

	Study I	**Study II**	**Study III**	**Study IV**
Study aim	To describe the testing behavior for genital *C.trachomatis* among youth in Stockholm County, with a focus on repeated testing.	To explore the motives for repeat testing for *C.trachomatis* among youth, and how testing affects subsequent sexual risk-taking	To explore health care providers' perception of youth testing repeatedly for *C.trachomatis* in Stockholm County	To evaluate the effects of a mobile phone intervention (mHealth) designed to promote safe sexual practices and improve condom use among sexually active youth in Stockholm County.
Study design	Retrospective register based cohort study	Qualitative interview study	Qualitative interview study	Pragmatic randomized controlled trial
Timeline of data collection	December 2013 to September 2015	April 2015 to April 2016	August 2016 to March 2018	October 2017 to October 2018
Study population	All youth (n=65 951) who tested for *C.trachomatis* in any of the YHC in Stockholm County between 1 of January 2010 to 31 of December 2012.	Heterogeneous sampling, 15 repeat testers. Youth aged $\geq$ 18 who attended the YHC and had tested for *C.trachomatis* $\geq$2 during the past 6 months.	Heterogeneous sampling, 12 health care providers at 10 different YHC in Stockholm County.	433 youth aged $\geq$18 who attended the any of the 8 participating YHC and had had $\geq$2 sexual partners during the past 6 months.
Data analysis	Descriptive statistics and survival analysis	Constructivist grounded theory	Content analysis	Descriptive statistics and regression analysis

3.3 STUDY METHODOLIGIES

3.3.1 Study I

Study design and population:

Retrospective cohort study. All youth who came to test in one of the 33 YHCs during 2010-2012 were included in the study.

Data collection: Registers of *C.trachomatis* tests from each of the three laboratories serving Stockholm County was used to assess all tests performed at the YHCs in Stockholm over a three year period (2010-2012). Each of the laboratories sent files containing personal identification numbers (PIN), date of test/tests, and test results to the Public Authority of Statistics Sweden (SCB), where socio-demographic variables were added, and PIN were replaced by a unique identification number. The data files were then merged into one. Due to reason of secrecy for medical records between the different YHCs and the different laboratories, a joint medical record for youth attending, and testing at different YHCs was not available without the above described process. Final data from the laboratories and the SCB was received by the research team during autumn 2015.

Data analysis: Descriptive analyses was used to report social-demographic characteristics of the cohort. The first test performed in one individual was considered the baseline test and marked the entrance of the study participant. Survival analysis was used to assess time to event (time to repeat test) and account for the different follow-up time for each individual in the study.

3.3.2 Study II

Study design and population: Qualitative interview study. We aimed to gain a deeper understanding of the individuals who repeatedly come for *C.trachomatis* testing in the YHCs, their motives for testing and how testing might affect their subsequent sexual risk-taking. Those who had tested for *C.trachomatis* at least twice during the previous six months were invited to participate in the study. In total we included 15 persons from eight different YHCs in Stockholm County. Participants were selected purposefully using heterogeneous sampling[155] so that youth from different socio-economic areas were represented. Each participant was offered two movie tickets for time spent in the interviews.

Data collection: A semi-structured interview guide with open ended questions was used to collect data. The interviews were conducted in Swedish, recorded and transcribed verbatim in Swedish. All interviews were performed by the same person. The interview guide is available as Appendix I.

Data analysis: The data was analyzed using a constructivist grounded theory approach.[156] The interview transcript was red through, after that a line-by-line coding of the data was done. Categories emerged from the data as a result of constantly comparing of codes from different interviews, and by reasoning and consensus between two researchers. The categories were linked together creating a theoretical model explaining motives behind repeat testing. Memo writing, i.e. writing down analytic notes throughout the research process, facilitated the analysis of the data and the codes, and ultimately drafting the paper.

3.3.3 Study III

Study design and population: Qualitative interview study. Designed to gain further understanding of the youth utilization of the testing services at the YHCs, sexual risk-taking among youth and primary prevention strategies. In depth interviews with 12 health care providers at 10 different YHCs, situated in different socio-economic areas of Stockholm County, were performed. Participants were selected purposefully using heterogeneous sampling[155] so that health care providers with different time experience from working at the YHC were represented.

Data collection: A semi-structured interview guide with open ended questions was used in data collection. The interviews were conducted in Swedish, recorded and transcribed verbatim in Swedish. All interviews were performed by the same person. The interview guide is available as Appendix II.

Data analysis: The data was analyzed using content analysis.[157 158] Transcripts were read through on several occasion, and a line-by-line extraction of meaning unit was done. The sentences were shortened into condensed meaning units. Coding was done, each meaning unit was labelled with a code. Codes from the different interviews were then compared. Categories emerged from the coded data as a result of parallel analysis and mutual in-depth discussions between researchers. Three different overlapping themes were identified.

3.3.4 Study IV

Study design and population: Study IV was a pragmatic RCT designed to evaluate the effect of a smart phone app to promote sexual health and specifically condom use among youth in Stockholm County. Individuals who visited any of the 8/33 participating YHCs were screened for eligibility. The participating YHCs were situated in different socio-economic areas of Stockholm. Each participant was compensated two movie tickets for participation.

The Study Protocol is presented in a separate publication[159] Our aim was to recruit participants both from the YHCs as well as through social media (advertising via Snapchat, Instagram, Facebook with redirection to the trial website for inclusion), however at the time for inclusion there were no prevailing guidelines or possibilities to create an account in social media originating from Karolinska Institutet.

Inclusion criteria: Age 18 to 23, smart phone ownership, ≥2 sexual partners in the last 6 months, and residential registration in Stockholm County.

Exclusion criteria: Unwillingness to participate, and women who exclusively have sex with women.

Randomization: Eligible participants were individually randomized in a 1:1 allocation ratio to one of two arms. 433 youth who fulfilled the inclusion criteria were included in the study, intervention arm (n=214) or control arm (n=219). Stratified (for sex) block, randomization was used.

Main outcome measures: The main outcome was self-reported condom use at the end of the study period. Secondary outcome measures were number of partners, occurrence of STI, pregnancies, and self-initiated STI tests.

Intervention: Smart phone app called "*Skyddsaget*" plus standard of care was compared to the standard of care. The development of the intervention is described in a separate paper (Appendix III).[160]

Standard of care: Standard of care was the normal routine at the YHCs which includes easy and prompt access to the clinics, exploring sexual behavior of the individual, giving recommendations and prescription of contraceptives, information about and distribution of condoms, testing for STI upon request from the youth and/or upon recommendation from the health care provider.

Data collection and follow up: All data collection and follow up data collection was collected thru the app. The control group received a dummy app were only follow up questionnaires were available. Data submitted via the app by the participant was electronically routed onto a database that was stored on a secure server. To secure the data transfer from the app, all data was encrypted by using a Secure Sockets Layer (SSL). Baseline- and follow-up questionnaires are available as Appendix IV.

Data analysis: Analysis was by intention-to-treat (ITT).[161] The primary approach used to handle missing data was "last observation carried forward" (LOCF). Analyses were adjusted for sex, condom proportion at baseline, relationship status at baseline, and previous experience of STI as these variables were expected to influence condom use. STATA v16 software was used for all analyses.

4. ETHICAL ASPECTS

Ethical approvals were for the four studies were obtained from the regional ethical board in Stockholm: 2013/1399-31; 2015/739-32; 2017/651-31/4; 2017/8080-32.

Given the sensitive subject of sexual health and behavior there were many ethical considerations in this project. Protecting the privacy of the patient is crucial at the YHCs and accordingly the recruitment procedures taking place at the YHCs was done with the objective to preserve this privacy.

For the interview study (Study II) and the RCT (Study IV) youth were recruited upon visiting the clinic. There was a possibility that the participant approached, could have perceived themselves in a position of dependence in relation to the health care providers at YHCs, and accepted to enter the study without a genuine wish to do so. However, the health care providers involved in the inclusions at the YHCs informed possible participants about the present study, allowing time for reflection, and emphasizing the right to decline participation. They were also given written information about the study.

The participants were informed, (prior to the signed the informed consent), that the questions during the interview and in the trial questionnaires would include intimate questions about sexual health and sexual habits. Written informed consent from each participant in the interview and the intervention study was obtained before the respective study was started.

Exploring people's sexual habits and condom use is an invasion of privacy and put additional demands on data privacy protection. The Swedish Personal Data Act, 1998:204 was followed throughout the trials.[162] Only members of the research team had access to data collected in the project. Data files are stored on secure servers accessible only on pass worded computers used solely by the researchers.

For the interview study with health care providers (Study III), written informed consent was obtained. The aspects of the researcher also being a colleague with the interviewees is discussed later in this thesis.

5. RESULTS

Overall results: among youth attending the YHCs, a significant proportion repeated testing for *C.trachomatis*. Easy access to the clinics and the testing services were highly appreciated by youth, however the test and the test result itself did not affect subsequent sexual risk taking at individual level. Health care providers' also expressed appreciation towards easy access to testing services, as it enabled individual sexual health counselling. In an attempt to complement and strengthen primary prevention strategies by a mHealth intervention, a youth friendly smart phone app was not found efficient. In the following section a summary of results from the different studies are presented separately. The results and its implications are further presented and discussed under in the discussion section.

5.1 STUDY I: WHO ARE USING THE TESTING SERVICES AND WHAT IS THE INCIDENCE OF REPEAT TESTING

All data originated from the YHCs in Stockholm County. In total, 65 951 (71.6% females) participants were included and 119 699 tests during 2010-2012 were analyzed. We found 42% repeat testers (≥ 2 tests) in the data. Among all testers, 24.7% re-tested within 6 months of the previous test, among repeat testers 58.9% performed the next test within 6 months. The median number of repeat tests were 3 (range 2-18). At baseline, 8.2% of all individuals tested positive. The overall positivity rate declined marginally by number of tests performed, 8.0% were positive at second test, and 7.9% were positive at third test. Repeat infection was found among 925/27 680 (3.3%) re-testing youth.

Of all re-testers, 80.3% were female (n=22213/27680). Men had higher rates of *C.trachomatis* positivity at baseline, both among single testers (9.8% for men vs 4.3% for women), and among repeat testers (17.1% for men vs 9.4% for women). Figure 9 shows the total number of tests and positivity rates among men and women separately. The incidence of repeat testing was 20.4/100 person-years for men, and for women the corresponding figure was 40.7. Repeat testing was associated with female sex and baseline positivity. Time to the second test was associated with the same variables. Women positive at baseline re-tested after 167 days (median) compared to men positive at baseline who retested after 182 days (median). Most repeat testers (70.8%) did not change clinic between tests.

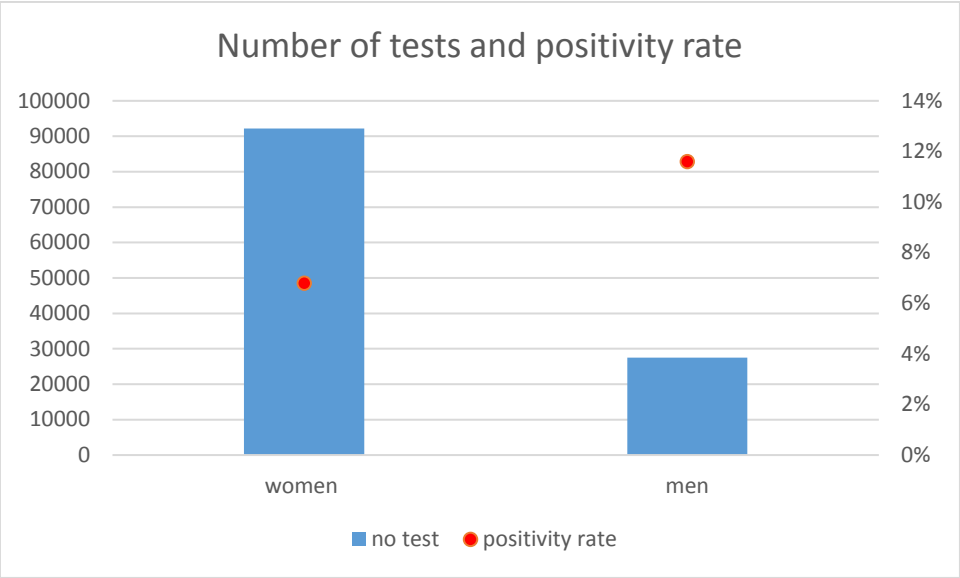

Figure 9. Total number of tests and overall positivity rate per sex

5.2 STUDY II: WHY ARE YOUTH TESTING REPEATEDLY AND HOW IS RISK-TAKING AFFECTED BY THE MEETING AT THE YHC AND THE TEST RESULT

Fifteen (eight women and seven men) repeat testers were interviewed about their motives for testing, and how testing effected their subsequent sexual risk-taking. Testing was found to be a cyclic process driven by different aspects such as fear of infection a peer, the health care accessibility, and the idea of repeated testing as a preventive measure replacing condom use. Even though *C.trachomatis* was not perceived a serious infection, testing was described essential to reduce the risk of social consequences of infecting a peer. In all interviews, social stigma in infecting a peer stood out as a major reason for frequent testing.

"The reason why youth test a lot is, you really do not want to be the one infecting someone else. I think that's why you go there to test …infecting someone is embarrassing, I wouldn't want to do that." (21 year old woman)

Hence, anxiety created due to possible social consequences was restrained by testing; youth tested to make sure they would not infect anyone and consequently bad rumors could be avoided. Furthermore, honesty towards a sexual partner was highly valued, i.e. being able to truthfully reveal STI status was considered important.

It was a prevalent opinion that good accessibility and free testing could lead to careless behavior and overuse of the services. The tests result (positive or negative) was not found to affect the retesting process, or the subsequent sexual risk taking, at least not towards more protective measures. A negative test result proved that unsafe sex was not that risky.

Youth also expressed that health care providers preferably should not ask questions about the reasons for testing or questions about the youth sexual life. Such questions were considered personal and private.

5.3 STUDY III: FINDING A BALANCE BETWEEN PRIMARY AND SECONDARY PREVENTION

In Study III, health care providers were interviewed to explore the YHCs testing services from a broader perspective. Three overlapping themes were identified in the data:

"Re-testing without having the talk is not meaningful"
"Understanding reasons behind risky sexual behavior is essential for preventive work"
"Having the talk: reaching out to promote condom use – challenges and opportunities"

Health care providers were aware that numerous youth test repeatedly, and that testing by some, is perceived equally protective as using a condom. However, the repeat encounters with youth in relation to testing were perceived as positive for various reasons, including to reassure a disease-free status or to treat an infection which interrupts the chain of infection. More so, health care providers saw repeat testing/encounters as their chance to interact and eventually reach all the way with primary prevention strategies such as information on condom use and ways to healthy sexual behavior. Nevertheless, without time for reflection it was considered, that testing was meaningless. Additionally, health care providers highlighted concerns regarding not reaching young men to the same extent as young women.

Health care providers recognized that *C.trachomatis* was not considered a serious infection. Thus using protection (condom) in relation to fear of medical sequelae was not a likely scenario. It was further emphasized that repeat testing might origin from a deep concern regarding other issues, such as

reimbursement for sex, general anxiety, or sexual abuse, and that testing was the youth way of reaching out.

The concepts of self-reflection, self-respect, and self-compassion in relation to sexual health was emphasized in the third study but did not emerge in Study II. Health care professionals used these conceptions to reach youth with sexual health promotion.

5.4 STUDY IV: MHEALTH AS A COMPLEMENT TO PREVENTION WORK

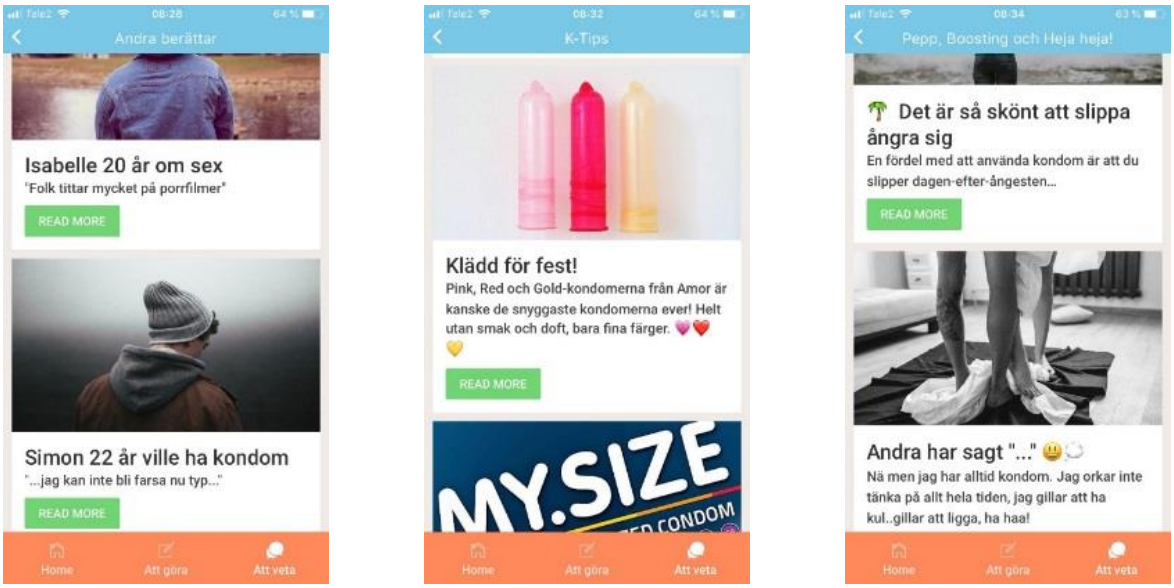

Figure 10. Screenshots from the mHealth intervention *"Skyddslaget"*

In a RCT we compared standard of care at the YHCs to standard of care plus the mHealth intervention (Figure 10), hence, the intervention was evaluated as a complement to routine prevention work carried out at the YHCs.

In total, 972 young YHCs visitors were screened for eligibility and 44.5% fulfilled inclusion criteria and accepted participation. Exclusion was most commonly due to not having had ≥2 partners during the past 6 months, followed by unwillingness to participate. Recruitment was done over a 6 month period. The duration of the intervention was six months.

Among the 433 participants, 67.4% were women, 96.3% were working or studying, 74.8% were living with their parents, and 89.1% were not in a steady relationship. Mean age for the first intercourse was

15.8 years, and the mean number of lifetime sexual partners were 15.8. The mean proportion of protected sexual intercourse at baseline was 31.5%, concurrent sexual relationships were reported by 70%, and 40.9% had previous experience of STI. More than half (51.5%) said they were always, or almost always intoxicated, by alcohol or drugs while having sex with a new or temporary partner. Almost one of four (23.3%) stated that they had sex with someone during the past six months, that they did not wish to have sex with.

In the intervention group, the proportion of fully protected intercourses (100% condom use) increased 8.9% to 15.0%. The corresponding numbers for the control group were to 11.4% to 16.0%. There were no significant differences between the intervention and the control group regarding primary and secondary outcomes. Therefore, evidence from our internet based randomized trial did not suggest that an interactive mobile phone based app could result in significantly increased condom use among the youth.

6. DISCUSSION

Main results in summary: Our first study showed that a significant proportion of youth attended the YHC repeatedly for *C.trachomatis* testing. As this was a retrospective cohort, the reasons for re-testing could not be elicited. However in a separate qualitative study, repeat testers indicated that testing was perceived as equally protective as using a condom, thus was used as means of prevention to avoid medical consequences, but foremost social consequences of infecting peers. Health care professionals saw 'repeat testing as a means of prevention' as a positive strategy for the youth to compensate for unsafe sexual practices, but only if the testing episode involved discussions around safe sexual practices and sexual health. In line with increasing number of efforts to affect sexual health we sought to study a mHealth intervention. We developed, implemented, and evaluated a smart phone app to promote sexual health. However, the intervention did not show an effect on the frequency of condom use among a group of sexually risk-taking youth. In the following sections, the main results/findings, methodology and broader implications from each study will be discussed.

6.1 STUDY I

6.1.1 Results discussion Study I

We concluded that the incidence of repeat testing, (35/100 person years), for *C.trachomatis* among youth seeking care at the YHCs in Stockholm County is relatively high compared to numbers reported elsewhere.[73 95]

We reached more females than males for STI testing (28% men) at the YHCs, most probably due to young women who can easily visit YHCs for other needs such as contraceptives. In Figure 9 (results section) we show that among > 90 000 female tests we found 6.8% positive cases, and among < 30 000 men 11.6%. It might be suggested that increasing the testing rate among men and a more strategic testing among women would be more appropriate. However, there is no cut off level at what amount of testing we wish to find a certain level of cases. It can also be argued that more frequent male-testing and re-testing, and keeping accessibility unchanged for young females would be most beneficial. Each encounter with the health care system offers opportunities for health promotion practices and accessibility should therefore be preserved. Young men outside the testing services and not in our study population, have a risk not being reached by sexual health related interventions.

When analyzing tests in order of testing episode (first, second, third), we found that the overall positivity level were approximately 8% at all tests regardless of order. This could indicate that the repeat testers constitute a risk-group and risk-reductive measures do not increase by number of tests/number of encounters with health care providers. Among repeat testers, 3.3% had more than one infections during the study period, i.e. were re-infected. This is lower than previously reported elsewhere.[163 164] One reason for promoting re-testing is to find people who are re-infected, either by a new sexual encounter or by an untreated partner. However, in our study, the level of re-infection was not high, and thus most infections among testers were attributed to persons who was previously uninfected. This suggests that the testing services are repeatedly being used by a number of sexually risk-taking youth who either haphazardly get the infection or they are `lucky´ enough to not be infected.

6.1.2 Broader implications of the results of Study I

We interpreted repeat testing as being "common" (42% re-tested ≥1 during the study period). However, in a study among STI-clinic visitors in Stockholm County, authors stated that "only" 43% of *C.trachomatis* testers had been tested in the previous 12 months, suggesting re-testing was not common.[29] Irrespective of interpreting repeat testing as common or not, it is interesting to evaluate the opportunistic screening approach from utilization perspective. Who do we test, how often, and why? Repeat testing after an infection, or annual screening are not routinely recommended in Sweden.

Each year all laboratories in Sweden are asked to report levels of *C.trachomatis* tests to the Public Health Authority. Some laboratories fail to report testing levels. Of those that does, most (70-80%) report number of tested persons,[20] and other report number of tests. Yet some laboratories report both number of tested persons plus number of tests. Consequently, there are no accurate national data available of the amount of persons tested within the opportunistic screening program, nor the number of tests performed. With repeat testing levels of around 40%, the number of tested persons in one year might be lower than presented if the number of tests are reported. On the other hand, the number of tests performed are higher than presented if reported levels only refers to tested persons. Population coverage at a certain level, i.e. the number of persons tested has been suggested as an important aspect of *C.trachomatis* prevention.[14] Consequently, without knowing the true coverage it is difficult to argue benefits and disadvantages of opportunistic screening.

6.1. Methodological discussion Study I

To establish the level of repeat testing at the YHCs, which to our knowledge has not been reported before, we approached the operating laboratories in Stockholm County for data collection. Data was collected from the laboratories and SCB during 2013. However, when we completed the analysis and final draft for the manuscript for Study I, it was discovered that the numbers sent from the laboratories were not accurate. Data from 1/33 YHC was missing completely, data for a whole year was missing from 3/33 YHCs, and positive test results were missing from 4/33 different clinics. This resulted in re-opening of discussions with SCB, and a complete remake of dataset. The validity of the new data was assured by data-comparisons with the official number of reported cases in the County (2010-2012).

Although only 40% of all positive tests that are reported in Stockholm County origins from the YHCs, we choose this as our setting. The remaining positive tests originate from, STI clinics, online sources, and various primary health care centers. The YHCs have a clear defined responsibility for primary prevention strategies among youth. On-line testing does not include personal contact with health care providers, and STI-clinics offering testing are aimed at older visitors. By restricting the study to the YHCs we most likely underestimated the level of repeat testing as a proportion of youth also use these other services.

The studied period was 3 years. We do not know testing history before the studied time period, nor after, which is a limitation of the study. Ideally a longer time span could possibly have resulted in more accurate calculations regarding repeat testing, though a longer study would also be hampered by the same lack of testing history outside such a study period.

In the present study, conducted to explore testing habits, a repeat tester was defined as someone who attended the clinics for a test more than once during the study period. This definition was pragmatically chosen to enable comparison to other international studies from the UK and New Zealand, reporting incidence of repeat testing and timing between tests.[73 95] While testing $\geq$2 times during a 3-year period might not seem much, this can still have implications for evaluating effectiveness of the testing services. To fully understand youth health seeking behavior and sexual health in relation to testing for STIs, it would have been ideal to link the laboratory data to medical/clinical records to look for motives behind testing and sexual risk-taking factors. However, no such link exists and reviewing almost 120 000 medical records manually was not feasible.

6.2 STUDY II

6.2.1 Findings discussion Study II

In our analysis a cyclic process related to *C.trachomatis* testing emerged. A positive test result and the consequent treatment was described as a "quick fix". The accessibility to testing services, the perceived non-severity of the infection, and the "quick-fix" notion came to affect the subsequent decision/self-negotiation to engage in unsafe sex. In this perspective, accessibility to testing services increases sexual risk-taking. Testing as means of prevention due to extensive accessibility could be described as an unintended side-effect of a well implemented screening approach.

Youth in our study, were being cautious in relation to sex in the sense that society (health care system) tells them to be, namely test after risky behavior. It became clear that there was no stigma related to this behavior, quite the contrary, it was perceived as a 'decent and appropriate' thing to do. While it can be argued that testing is more costly than condom use, and therefore wasteful of health care resources, it is indeed a way of reassuring a disease free status and prevent transmission. By understanding the processes of unsafe sex, testing as means of prevention, "quick-fix", and stigma related to infecting others, health care providers can adjust counselling.

6.2.2 Broader implications from Study II

Positively, scaling up STI prevention programs are currently being implemented around the globe. An increasing number of reports suggests that rates of re-testing/repeat testing are too low and therefore need to be improved and focused to specific risk-groups.[165 166 167 101] Even though it is not official policy in Sweden, repeat testing is frequent among youth. Findings from our study adds an important aspect regarding prevention strategies for *C.trachomatis* and other STIs. It implies widespread testing and availability according to the Swedish model might increase sexual risk-taking and non-condom use. We cannot conclude that accessibility is contra productive, however we describe a possible "side-effect" of screening which should be taken into account when scaling up prevention strategies. Testing and treatment will have implications for the individual at the time of infection, but does not necessarily affect behavior in the long-term perspective.

Youth interviewed in the present study reported no fear of becoming infected by *C.trachomatis*. Additionally, HIV was not perceived as a real treat in this group, which by large could be an adequate

assumption. Nevertheless, increasing reports on antibiotic-resistance in gonorrhea bacteria[168 169] might enhance population positivity towards primary prevention for STIs (discussed below).

6.2.3 Methodological discussion Study II

In this study, we defined repeat testing as $\geq$2 tests per 6 months (corresponding to approximately 16 300 youth in Study I). This definition was chosen by the research team as a realistic time interval to capture youth who routinely/repeatedly test for *C.trachomatis*. It is possible that some interviewed in this study was also part of the previous dataset. However, the participants were recruited from different YHCs and upon new visits, not from the original dataset.

Reasons behind repetitive STI testing behavior and its effect on subsequent sexual risk-taking has not been widely studied. This led us to choose a grounded theory approach as it allows finding relationships between categories and possible development of new theories. A classical grounded theory as described by Glaser and Strauss,[170] differs from the constructivist grounded theory as described by Charmaz that was used in this study.[156] Constructivist grounded theory implies that findings are being constructed during the interaction between the researcher and the informants as opposite to being objectively discovered.[156 171] The classical grounded theory believes in one reality on a phenomenon of interest just waiting to be found and the constructivist approach acknowledge that reality is being constructed during the interaction and that there is more than one perspective of reality.[171] Furthermore, in the constructivist grounded theory, the personal experience and knowledge of the researcher is considered an asset while interpreting the data. Accordingly, in our study, the researchers' pre-knowledge in the area being researched was the main reason for choosing the constructivist grounded theory approach.

Saturation is a widely used term in qualitative research describing a situation when purposive sampling can be stopped. In recent years there has been some debate regarding the definition of the term and to what part of the qualitative work saturation refers.[172] It has been described as when a category is full, i.e. no additional data emerge and properties of the category can be determined. Saturation can also be defined based on the coding of the data, i.e. when no more new codes are found. Additionally, saturation has been described as something that occurs in the interview situation.[172] We defined saturation as no more new emerging codes. Data appeared saturated after approximately 12 interviews, however we conducted three more interviews to assure saturation.

Within the interview guide (Appendix I), a vignette describing a typical repeat tester was used. The purpose of the vignette was to use a hypothetical person to approach a sensitive topic.[173] However youth spoke freely about the subject and thus this technique was only used in one third of the interviews. Trustworthiness in this study was assured by participants being presented with a summary of their responses in the end of the interview session as they were asked to confirm or contradict the information presented to them.

6.3 STUDY III

6.3.1 Findings discussion Study III

In the interviews with the health care provider's we identified three overlapping themes in their perception of repeat testing for *C.trachomatis*, sexual risk-taking, and primary prevention strategies. The phenomenon of repeat testing as means of prevention was acknowledged, however it was not necessarily perceived as problematic by all participants. Testing and attending the clinic repeatedly were looked upon as an opportunity for primary prevention including behavioral change interventions by counselling. In that context limiting access to testing services or restricting accessibility should not be considered. However it was stressed that "finding a balance" between primary and secondary prevention is desired, namely by time to meet the needs of the youth, time to problematize, and time to create alliances, as well as time for in-depth and risk-reductive communication. More than focusing on number of partners and number of unprotected intercourses, health care providers discussed implying self-respect and self-compassion to support youth in taking care of themselves.

Furthermore, participants highlighted the need to recognize that "we are working with the adolescent brain". Neuroscience research has shown that the brain is not fully developed until the age of 25, and accordingly optimal decision making might be limited up until that age.[174] The need to incorporate this knowledge in respect to sexual health issues has recently been recognized,[175] [176] and should be considered when aiming to improve sexual health among youth.

6.3.2 Broader implications of Study III

In line with findings from our study where health care providers gave emphasis to primary prevention strategies as long-term work, interventions over time were found superior to single session interventions.[177] With current demands of productivity, accessibility, and promptitude, both from

youth and the health care system, the obvious "quick-fix" solution of testing and treating, is perhaps the most tempting way to go even though findings from this project suggests no long term sustainable effect of focusing on secondary prevention.

Only half of youth in a population based study in Sweden, reported to have had a preventive discussion in relation to their last STI testing.[34] Reasons behind this was not described, however it could perhaps be attributed to time constrains. Together, these finding has implications for the health care system, i.e. finding a balance between productivity and quality. Short meetings at drop-in hours seems highly appreciated by the youth, but not by health care providers who demands sufficient time for reflection.

Preventive strategies tend to be weighted in favor of secondary prevention, which is indeed advantageous to the youth as it provides them access to test and stay infection free. Promoting secondary prevention strategies might also be easier to report and evaluate compared to detecting behavioral change in relation to sexual health. Nevertheless, we should constantly be aware of the balance between primary and secondary prevention and how it corresponds to the goals of national *C.trachomatis* prevention.

6.3.3 Methodological discussion Study III

Data was analyzed using a content analysis approach as described by Graneheim and Lundman.[157 158] Compared to the grounded theory approach, content analysis does not aim to find a relationship between categories and develop new theories, but rather identifying, extracting and describing categories within the data. In this study we did not aim to find a new theory describing a phenomenon, but to triangulate findings from the previous study and additionally to describe health care providers view on sexual risk-taking and prevention strategies. Therefore, a content analysis approach was more found more appropriate than a grounded theory approach.

Trustworthiness of the data was assured by member check, i.e. validating emerging understanding of the data with the informants.[178] Furthermore, consensus on the codes, categories and themes were established by two researchers with different background. Additionally, findings from Study III were triangulated with findings Study II. Possible pitfalls from previous exposure and familiarity of the researched settings were avoided by constant awareness of the relationship between the researcher and the subject as well as the informants.

6.3.4 Trustworthiness in Study II and III

In qualitative research trustworthiness is made up by four different elements: credibility, transferability, confirmability and dependability. *Credibility* refers to the researchers' confidence the truth of the findings. Credibility is increased if the researcher are familiar with the setting before data collection was started, which was the case in the current studies. I spent approximately 3 years working at the YHC before data collection begun. Pre-understanding of the researched area facilitated identification of content themes which improves credibility. Further credibility can also be achieved by triangulation of findings which was done and discussed above.

Transferability, refers to how applicable the findings are to other contexts than the one studied. For this purpose it is important that the setting is described in detail so that the reader can evaluate whether the findings could be applicable in other similar settings. In both qualitative studies of this thesis the setting was carefully described in the methods section. In similarity to generalizability, transferability of the findings in the two qualitative studies would foremost apply to an urban, high income setting where accessibility to health care services has been a present for a long period of time.

Confirmability, refers to the level of neutrality in the findings, i.e. are the findings based on the responders' answers or the researchers' interpretations. It was with pre-knowledge and some preconceived opinions of health care utilization in relation to testing, that I went in to this project. Over the years my feeling on repetitive testing has changed towards a more positive view. During the years I have come to appreciate the pragmatic way that youth are handling consequences of their actions. The health care system offers solutions and youth accepts these. There was of course a risk of misinterpretation of the data due to pre-knowledge. It was avoided by continuous reflection and feedback discussions with research team members. Furthermore, my pre-conceived opinions did not match the findings from the studies. This was foremost apparent in the health care providers' interview study, where responders offered a multi-dimensional view on primary and secondary prevention strategies that differed from mine. More so, each step of the analysis processes has been documented and the analysis process was done together by two researcher from a different backgrounds.

Dependability, refers to the possibility for other researchers to repeat the study and would the findings then be consistent. Dependability was assured by describing the analysis process thoroughly in the methods sections. We triangulated the researchers' interpretation of the data. Additionally, we

performed member checks, i.e. we validated the understanding of the data with the informants by asking interpretative questions related to the emerging themes.

6.4 STUDY IV

6.4.1 Results discussion Study IV

In our RCT condom use and proportion of fully protected intercourses, did increase with approximately 5% in both groups. The low condom use in this group of youth is a finding in itself and should be highlighted, communicated and if possible tackled. Secondary outcomes did also indicate a continued sexual risk-taking as approximately 20% experienced an STI and 70% tested at least once during the 6 months period.

We aimed to increase condom use but the intervention did not have any effect in the "intention to treat" analyze. We do not believe that this was because of a Type II error. Even a larger sample size should not have allowed us to detect an effect. We conceive that there was no effect of the intervention as this was confirmed in a number of additional analyzes as per protocol, best-case scenario and worst-case scenario. By imputing values according to different methods we accounted for different possible scenarios (further described below). No statistical differences were detectible in any of the analyzes.

While the documentation of the usage level of the intervention is not complete due to technical problems, it was still sufficient to indicate that youth interest in the app waned after approximately 3 months. This could also be deduced from the need to remind youth to answer the later follow-up questionnaires. Among the intervention group, 17% (30/176) of those answering the first follow up questionnaire, needed log in information again. Difficulties with influencing how much participants use the intervention (dose) has previously been described in similar RCTs.[179] In additional to lost to follow-up there was most likely also a non-usage attrition. Both these are closely linked to one another. High rates of loss to follow-up indicates a high proportion of non-usage of the intervention among those who stay in the study,[180] which consequently could represent that the participants did not find the intervention/app engaging enough.

Participants in the RCT did not actively seek the intervention, which could influence the number of lost to follow-up. Conditions perceived as problematic to the participant, for example heavy

drinking,[179] weight problem,[181]or herpes,[182] could affect the will to stay in the study. As presented in Study II, non-condom use is not perceived as a problem that needs to be fixed. More so, it is possible that the intervention could have been effective in increasing condom use if targeted to an even younger population, i.e. even before sexual debut. As reported in Study III there seem to be a fascination for condoms in younger years that is eventually lost. By targeting the younger population, condoms could conceived as a natural part of the sexual life.

6.4.2 Broader implications of Study IV

Based on reported mHealth interventions, we had hopes for the intervention to serve the set purpose. We focused on developing the intervention together with youth from the target group,[160] and we anticipated youth to want to interact with the app (Appendix III). Still, perhaps youth feel no need to be further informed or influenced to use a condom. Additionally, approximately 70% had tested for STI at least once during the study period, and participants could have used testing instead of condom as described in Study II, and consequently feel sufficiently protected as a result of testing.

mHealth interventions that reports increased condom use has targeted younger people than we did.[183] More so, effect was measured after three months,[184] there are data implying that the effect of mHealth interventions decrease with time.[135] We believe a mHealth intervention such as ours should still be considered in a resource constrained setting or settings where access to primary and secondary prevention are low.

6.4.3 Methodological discussion Study IV

In designing the study we used the PRECIS-2 tool (Pragmatic Explanatory Continuum Indicator Summary),[185] to ensure applicability of the trial results to the group the intervention intended to target. The pragmatic design of the trial (explained in further detail below) aimed to investigate if the intervention has an effect under existing routines, as opposite to ideal conditions.

The trial protocol was registered at International Standard Randomized Controlled Trials ("Mobile Phone for Sexual Health in Youth" ISRCTN13212899[186]). A protocol paper was published[159] shortly after inclusion started. To assure transparency of all important aspects, it was reported in line with the CONSORT checklist (Consolidated Standards of Reporting Trials).[187 188]

Participants in Study IV (and Study II) were recruited at the YHCs. We recruited persons ≥18 years old. By only including youth who could sign the informed consent without consulting their parents, the privacy of youth were maintained. Including from schools might have given a more representative selection of youth in Sweden in general, we decided to exclusively recruit from the YHCs, as this was more logistically feasible for the research team. Eight different clinics recruited participants. Geographically the clinics represented different socio-economic areas ranging from high income areas to low income areas with a higher migrant population.

We targeted youth with risky sexual behavior, defined as at least two sexual partners during the past 6 months. Youth attending the YHCs represents a risk-group, i.e. they are usually sexually active as compared to youth in general (e.g. in school environment), thus recruiting from the YHCs seemed appropriate. By including those with ≥2 partners we minimized the number of participants currently in a stable relationship. We anticipated the risk of including those who were previously in a stable relationship and had moved on to the next stable relationship within the past six months. In total 10% stated they were in a stable relationship at baseline. Furthermore, our experience indicated that youth move in and out of relationships, therefore ≥2 partners during the previous six months would effectively excluded those in a long term relationship. By recruiting a risk-population, the results could become less generalizable, on the other hand only risk-taking youth will need to change behavior.

Our primary outcome was self-reported condom use. In relation to STI prevention we considered condom use as the most important. Indeed, risk of contracting STI increases with number of partners, (which is why this was included as a secondary outcome), however, if a condom is used any infection risks associated with having numerous partners is decreased. We considered including laboratory test results as an outcome, but due to feasibility and financial constraints, our secondary outcomes were self-reported testing episodes and self-reported occurrence STI. Due to accessibility at the YHCs we considered that those in need of a test would go to a clinic, thus did not need test-kits sent by mail. Occurrence of pregnancy was included as secondary outcome although pregnancy was not targeted in the app. Nevertheless, pregnancy would probably be less susceptible to recall biases than number of partners/protected intercourses, and could therefore serve as an indicator of unprotected sexual intercourse.

Power calculations assumed a condom use level of 50%, supported by previous reports in population based studies in Sweden.[42 49] However, as we recruited a high risk group, retrospect calculation reviled an overestimation of baseline condom use.

Questionnaires were designed so we could calculate mean proportion of condom use in the two arms. At baseline the mean proportions was approximately 30%, it did increase in the intervention group over the first 3 months however it then reverted to the same level as at baseline. Our outcome is based on 100% condom use, i.e. using a condom every time during an intercourse. We argue that consistent condom use is important in the STI context. Only with 100% condom use the primary prevention target of zero risk of infection is met.

Given the above a person with a steady partner who did not use a condom would have a zero percent condom use and would then be considered equally unsafe as someone having had 6 partners without condom. In the analysis we therefore adjusted for relationship status at baseline.

Youth life is a time of rapid changes in terms of living arrangements, relationship status, and smart-phone ownership. From literature reports high loss to follow-up rates are described in on-line trials and we anticipated that keeping participants in the trial could be a challenge. Eligible participants consented to researchers reminding them via text message (SMS) or e-mail if responses to questionnaires were not provided a few days after the expected date. Participants were contacted via the mode chosen on the day following the expected response day. Those who still failed to respond to the questionnaire were contacted again after two days, and again two days following the second reminder, i.e. three reminders where sent out during the week after the expected response date. Participants in the control group also received an app, a dummy app containing only the follow-up questionnaires. This was done to facilitate the transfer of the data to the database.

In total 358/433 (82.6%) participants answered the first follow-up questionnaire. Among these 76 (21.2%) responded without any reminder (equal in both groups), and 161 (45.0%) answered after the first reminder. There were similar proportions for the responses to the second follow-up questionnaire. Methods for keeping participants in on-line trial by sending reminders has been previously described.[189] [179] In our study youth were given two movie tickets upon inclusion, no further inducements were offered. Financial inducements and shopping vouchers have been described to increase levels of

completed follow-up questionnaires. The higher the value of the voucher, the higher retention rate was reported.[189]

6.4.4 Internet based trials and high rates of loss to follow-up.

In a fully on-line RCTs the researcher's never meet the participant. Recruitment, randomization and follow up is done via the internet.[190] In a partly on-line RCT, like ours, either inclusion or follow-up is made in a traditional face-to-face manner.[190] There are several advantages with an on-line based trial. Trial recruitment via the internet can be highly efficient. In an on-line-based RCT aiming at increasing sexual health, 2000 participant were recruited via Facebook in five months.[189] Reaching potential participants at a low cost and, reaching groups that would be otherwise be unavailable for clinical recruitment are other advantages.[190] It has been argued that on-line recruitment can increase the external validity, i.e. by facilitating inclusion of different groups in society.[179] Additionally, participants has been reported to appreciate the anonymity of an on-line trial, especially for sensitive variables such as hazardous alcohol drinking[191] and sexual health.[128]

Among disadvantages with on-line conducted RCTs, the perhaps greatest concern are the commonly and large, loss to follow-up. A systematic review reported, 47% lost to follow-up for fully on-line RCT, and 36% lost to follow-up for partly on-line RCT.[190] Individual trials that were not included in the systematic review also reported similar high numbers of lost to follow-up. [189] [192] [193] Retention rates as low as 15% was reported in an on-line-based trial aiming to increase STI preventive behavior among men who have sex with men (MSM).[194] There are however reports on low rates of lost to follow-up in on-line trial with retention rates of 80-90%.[182] [195]

The large number of loss to follow-up in on-line RCTs makes these trials more suitable for pragmatic RCTs rather than an explanatory RTCs. Explanatory RCTs evaluate the effectiveness of an intervention in a controlled setting,[196] thus online based RTCs with large number of loss to follow-up will not be suitable for trials aiming to investigate the effect of an intervention in an optimal setting. On the other hand a pragmatic RCT is used to evaluate the effect of an intervention in a real world setting, under the same conditions as where it should be applied.[196] An intervention on sexual behavior delivered via an app, will not appeal to everyone but only a group of the target population. Therefore, despite the large number of lost to follow-up, an on-line pragmatic trial was suitable. The total number of lost to follow-up in our trial was 29.6% (128/433).

6.4.5 Intention to treat and handling missing data

To maintain the advantages of randomization, i.e. minimize the risk unforeseen biases and confounders, it is important to analyze participants as they were originally randomized. Additionally, to avoid attritions biases, all randomized participants should be analyzed as randomized i.e. on an "intention to treat" basis which is a commonly described and accepted approach.[161] The "intention to treat" approach with a "missing at random" assumption was described in our study protocol and subsequently executed.[159] Missing at random means that a missing observation has nothing to do with the missing values, but it is conditional of other observed variables (such as age or sex).[197-199] More male participants were lost to follow-up. However, stratification by sex was done previous to the randomization. There were no differences between those lost to follow-up in the control as compared to the intervention arm. There were no significant differences between those who completed the study and those lost to follow-up with regard to key baseline characteristics.

In our protocol we failed to state how missing data would be handled in terms of the details of the imputation process.[159] Imputation of missing data ensures the "intention to treat" approach,[161] we chose to impute according to "last observation carried forward", which is widely used method (however, not without criticism). An "intention to treat" as opposed to a per protocol analysis will not overestimate the effect of the intervention.[200] Additionally, we performed sensitivity analysis (best and worst case scenario) as well as per protocol analysis as recommended.[161] By performing per protocol analysis, i.e. only including those who answered to the follow-up questionnaires, the effect of the intervention was expectedly increased in magnitude (though still non-significant statistically).

6.4.6 Internal validity

Everyone who performed a test at the YHCs during a three year period was included in the first study, why there is no risk of selection bias. The risk of selection bias in the RCT was foremost related to high levels of non-consenters. During recruitment disproportionally more men than women declined to participate due to lack of interest and time. Men included in the study reported a higher means of condom as compared to women. It is possible that risk-taking men to a larger extent declined participation and thus the difference in condom use between men and women is due to selection biases in men which might have affected calculated odds ratios. It is possible that the intervention could have been more suitable to a more risk-taking group of men than we included. However, both men and

women were considered risk-takers, consistent condom at baseline were 13% for men and 9% for women respectively.

Self-reported condom use, the primary outcome, is hazardous in both report and recall bias. We tried to minimize the risk of report bias by not choosing a Likert scale outcome, but a numeric outcome, i.e. number of fully protected intercourses with partner(s) were divided by number of partners. A Linkert scale would possible provide more subjective estimates. In studies where sensitive issues such as sexual health are explored there is also a risk of participants reporting socially desirable answers. This could have resulted in reporting a higher level of condom use than the true level. A sign of social desirable answers/bias could be that both control and intervention group increased the reported level of condom use during the study period. Young men's higher reported condom use compared to women could indicate the same. Nevertheless, with the low reported levels of condom use in this study, we do not believe the risk of socially desirable bias to have affected the study substantially.

We used self-reported measurements for both primary and secondary outcomes. Participants were asked to report events from 3 to 6 months back. Number of protected intercourse and number of partners ranged from 0-10, occurrence of pregnancy and STI ranged from yes-no, and number of tests enabled in a range of 4 different response option including "I don´t remember". While recall bias is most definitely present in the study outcomes, we anticipated that most youth remembered important events that defined the primary and secondary outcomes. The questions used had previously been validated,[201] furthermore, they were piloted in the target group.

6.5 OVERARCHING METHODOLOGICAL CONSIDERATIONS

6.5.1 Generalizability and external validity

The setting of this thesis is the YHCs, and as in all clinical based studies there is a limitation with generalizability to the population outside the study setting. Our studies were done in an urban capital city with easy access to multiple YHCs and STI-clinics which further diminish external national validity. Furthermore, among those visiting the YHCs we sought a risk-taking population, i.e. those testing $\geq$2 per 6 months, and those with $\geq$2 sex partners during the past 6 months. Compared to population based studies among youth in Sweden,[34 42 43] data from our study participants did indeed indicate that had we recruited a higher risk population (condom use 10% compared to 25-50%). However, it has

previously been described that a small group of the youth population account for a large amount of *C.trachomatis* infections in Sweden,[37] and with the focus of this thesis being *C.trachomatis* testing and prevention, we sought to capture what is going on within this risk group. The results from the first study reflects results from a STI-clinic based study,[29] which extrapolates the results to people using the STI testing services in general. Yet, because of the large sample size in the first study (65 951 persons, 119 699 tests) including all who tested at the YHCs, we can still extrapolate the conclusions to a large segment of the youth population in Stockholm County. The proven non-effectiveness of the app in our RCT proves it is not useful in this risk-group, but it might well be so in other setting.

Even though the study is clinical based in an urban area in a high income country, findings from this thesis can still be of interest for populations in other settings. It has previously been described that the Swedish model is a role model example of *C.trachomatis* prevention, hence our findings, some 30 years after implementing opportunistic screening could imply what is to come out of scaling up testing services which is currently being done in countries around the globe.

6.6 WHAT DO THE RESULTS TELL US

6.6.1 Testing is done repeatedly by a proportion of youth

Opportunistic testing for *C.trachomatis*, supported by the infectious disease law and the health care law,[63 151] is offered to the population upon health care visits or via on-line testing. Ultimately, the objectives of screening for *C.trachomatis* are to reduce the spread of infections and to prevent serious reproductive health consequences in the population, which can occur both if the infection is treated or left untreated.[81]

There are several aspects that have to be considered before establishing the medical benefits, as well as the cost-effectiveness of opportunistic screening for *C.trachomatis*. One is: can screening affect the prevalence of *C.trachomatis* in the population? A cluster randomized controlled trial from Australia including youth participants, found no *C.trachomatis* prevalence differences between the intervention – intensified repeat testing - and the control group, during a three year period.[25] Conclusion made from the study was that reduction of *C.trachomatis* prevalence might not be possible using an opportunistic screening approach. It has been suggested that a reduction in *C.trachomatis* prevalence is possible if 30%

of the targeted population is screened on a yearly basis.[93 202] We showed that a number of youth uses the testing services repeatedly, thus the population coverage is most likely overestimated.

Usage level of the testing services (who tests and how often) in Sweden seems to be unclear even to policy makers and stake holders. We suggests that it is utterly important to investigate this further, i.e. replicate Study I from this thesis on a national level and thereby ascertain how many tests are done in the country every year, and how many people we reach through opportunistic testing. Without this knowledge we argue that it is impossible to make correct assumptions regarding benefits or disadvantages related to screening for *C.trachomatis*. We do not know who or how many we reach, nor who we do not reach. Reporting cases per 100 000 inhabitants is indeed important as it enables comparisons between countries. Nevertheless, it would also be important to report levels of *C.trachomatis* based on tests performed and tested persons.

Another aspect to consider while evaluating the opportunistic screening approach is: how many would suffer server sequelae if *C.trachomatis* is not treated? While approximately 20 % of PID diagnosis can be attributed to *C.trachomatis,*[203] 1-4% of untreated *C.trachomatis* lead to PID.[10 75] It has been estimated that 45% of tubal infertility can be attributed to *C.trachomatis* infection,[204] and that the probability of tubal factor infertility for women who had *C.trachomatis* range from 1-4%.[205 206] Today risk of severe consequences appears to be lower than previously reported. Furthermore, the effectiveness of screening on severe consequences depends on time for the infection to ascend to the upper genital tract and cause for example tubal damage, which is unknown.[13 207]

This thesis did not aim to evaluate the cost-effectiveness of STI prevention. The total cost of STI prevention among youth in Stockholm and Sweden is difficult to measure. Primary and secondary prevention for sexual health include ongoing activities involving many actors such as schools, YHCs, parents, peers, and the regular health care system. However, cost-effectiveness analysis including quality adjusted life year calculations based on up-to-date assumptions of risk of sequelae should be attempted. In studies from Sweden cost-effectiveness were based on assumptions that 20-30% of untreated females would suffer from PID,[77 208] and the risk of tubal infertility 4-6% .[77 208] It might well be that the opportunistic screening approach of today is beneficial, concerning cost-effectiveness related to severe reproductive health complications. Until we have reliable data, we cannot conclude either. Furthermore, nowhere, including Sweden, is there a target, or a defined acceptable prevalence

level of *C.trachomatis* or health consequences thereof ,[14] which makes it even harder to evaluate the effects of on-going activities.

6.6.2 Testing can impair risk-reduction

With extensive health care resources invested in prevention strategies, it is clear that the state and the authorities perceive *C.trachomatis* to be a serious infection. However, it appears youth are not of the same opinion. Findings from Study II and III imply that accessibility to testing even can have negative effects on sexual risk-taking. Youth are affected by the environment in where they live, i.e. YHCs, health care provided free of charge, and health care policies. Additionally, health beliefs such as *C.trachomatis* not being a severe infection and accessibility to health care services affects the sexual risk-taking. Youth express simultaneous yet contradictory feelings regarding *C.trachomatis*. On one hand it can be worth not using a condom despite contracting an infection, i.e. nothing to fear in relation to unprotected sex. On the other hand STIs can be devastating in relation to rumors among peers and perceptions of "being fresh". Testing repeatedly takes care of the fear of social stigma. In the interviews the outcome of the meeting with the health care service was referred to as easy and pleasant, thus no need for health behavior change was needed. Interestingly, health care providers did express a belief that in the long term they would be able to affect youth towards a more protective behavior, however this was not confirmed by youth.

Access to testing services is further facilitated by increased number of on-line tests performed during the past decade (Figure 11).[209] According to findings in Study III, testing without primary prevention strategies/talk is not meaningful and this knowledge contradicts scaling up on-line testing. Furthermore, the same confusion regarding tested persons/tests performed also applies for on-line tests in Stockholm County.[209] Indeed, with on-line testing we could potentially reach more people at a lower cost (240 SEK including testing material, analysis, and sending the sample by mail [210]) as the cost of health care providers is diminished. However, one must keep in mind that the health promotion initiative will be absent. There is a possibility of accessibility impairing risk-reduction among youth, and on-line testing could potentially increase this risk even further. Consequently, the discussion regarding the benefits of secondary prevention should include scaling up on-line testing services as well.

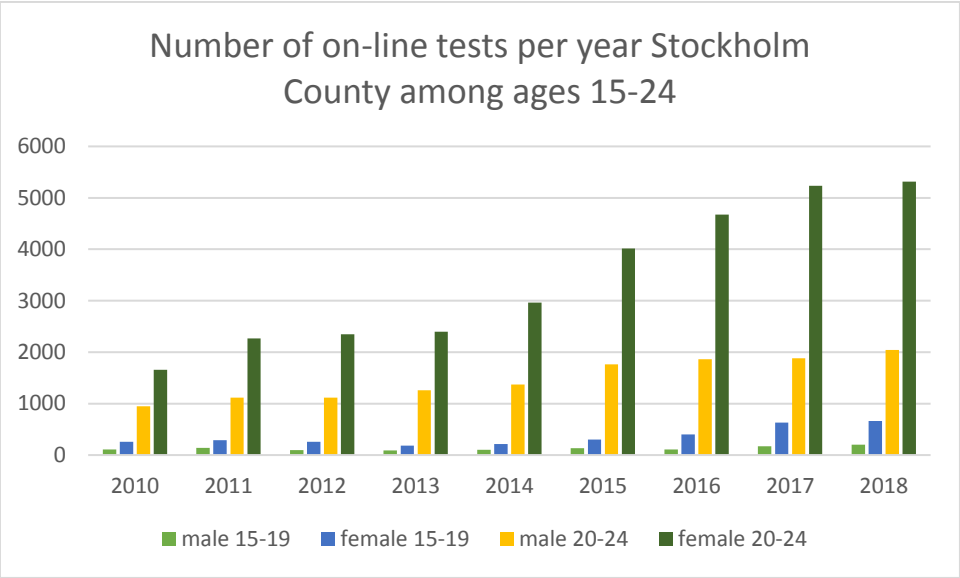

Figure 11. Number of on-line tests performed in Stockholm County ("Chlamydia on line") 2010-2018, divided by age group and sex.[209]

6.6.3 Behavior change needed but are we facilitating it effectively?

Among visitors at the YHCs, categorized as risk-taking youth, we found low condom use. Only 10% of youth were fully protected, which indicates a need for behavior change. As described throughout the thesis, "test and treat" is a feasible approach (and embraced by the youth) to decrease the risk of spreading the infection and minimize the risk of complications. However, it will not prevent infections per se. While it is positive that youth have adopted the test and treat approach, it is not optimal. Without making the best the enemy of the good, this approach is not conducive to safe sexual practice as routine among youth, which would be the ideal desired behavior as far as *C.trachomatis* control is concerned. Additionally, there are economic implications, the price of one condom ranges from 3-13 SEK,[211] which is much lower than the price of a test. More alarmingly, in the past years there have been a significant increase in gonorrhea (15% per year 2009-2015), foremost among MSM, but also via heterosexually transmitted infection among younger age groups.[212] Given the emerging antimicrobial resistance for gonorrhoea,[213]and risk of STIs overall, we argue that ultimately a change of behavior among youth i.e. increased condom use, is essential in a broader context.

Motivation is fundamental to behavior change. An important issue to youth was the possible social stigma among their peers about being held 'responsible' for spreading the infection. This notion was one we tried to emphasize in our mHealth intervention -not increasing stigma, but appeal to, and

strengthen youth's motives to act in a way that does not result in anxiety related to stigma. However, the mHealth intervention did not produce a significant improvement in condom use. We need to still explore and test interventions that will facilitate a sustainable change of behavior among youth towards adopting safer sexual practice (i.e. increased condom use) as a routine.

7. CONCLUSIONS

- The testing services of the YHCs are repeatedly being used by a significant proportion of youth.
- Testing is, by some repeat testers, perceived as equally protective as using a condom.
- Secondary prevention - in its current form - is unlikely to affect sexual risk-taking towards safer sexual practices.
- Spreading *C.trachomatis* among peers can have serious social consequences and testing after each unprotected intercourse will minimize this risk.
- Finding a balance between testing and primary prevention strategies by having the time for reflection and problematizing of risky sexual behavior is essential for successful prevention of *C.trachomatis* and unsafe sexual practices.
- Among sexual risk-taking youth visiting the YHCs, condom use is low, which indicates the need for primary preventions strategies to be strengthened.
- The evaluated mHealth intervention, a smart phone app, developed to increase sexual health did not influence condom use among youth.

8. SUGGESTIONS FOR FUTURE RESEARCH

To further explore the opportunistic screening services for *C.trachomatis,* Study I should be replicated on a national level, i.e. include all laboratories and County Councils in Sweden in a national survey to assess population coverage (number of persons tested) and number of tests performed in the country per year.

Results from the national population coverage study can be included in cost-effectiveness analysis for opportunistic screening for *C.trachomatis*. In addition, such a study should be based on up-to-date assumptions of the relationship between the infection and its possible consequences.

Exploration with youth living outside the urban areas to investigate how accessibility to testing services affects sexual risk-taking and testing habits. Further exploration of health care provider's perception of prevention strategies in relation to testing services in other outside-urban settings.

Qualitatively explore with participants from Study IV why the intervention was/was not found engaging.

Further exploration of the possibility of using individually targeted mHealth intervention for at-risk-population in this, and other settings.

9. SVENSK SAMMANFATTNING

9.1 BAKGRUND

Varje år smittas uppskattningsvis 350 miljoner människor i världen av en av fyra sexuellt överförbara infektioner (STI) (klamydia, gonorré, syfilis eller trichomonas). Klamydia är den vanligast rapporterade STI, både globalt och i Sverige. Ungdomar drabbas oftare än den äldre populationen. Klamydiainfektionen kan ge allvarliga komplikationer framförallt hos kvinnor, såsom infertilitet och kronisk smärta. För att förhindra spridning av STI krävs en rad samverkande åtgärder såsom sexualundervisning, kondomdistribution och tillgång till vård inklusive provtagning, behandling och smittspårning. I Sverige är sexualundervisning i skolan ett obligatoriskt moment och tillgången till vård är god. Sverige har en lång tradition av att tillhandahålla gratis klamydiaprovtagning. Redan 1982 erbjöds kvinnor som genomgick abort eller preventivmedelsrådgivning provtagning för klamydia. Även partners till smittade kvinnor kontaktades via smittspårning och fick lämna prov. Klamydia ingår sedan 1988 i Smittskyddslagen. Trots dessa förbyggande åtgärder så ökade antalet rapporterade fall av klamydia under de senaste två decennierna och har nu stabiliserats på en hög nivå. Nationella studier utförda i Sverige, rapporterar låg kondomanvändning bland ungdomar.

9.2 ÖVERGIPANDE SYFTE

Syftet med detta projekt var att studera provtagningsvanor för klamydia bland ungdomar som besökte ungdomsmottagningarna i Stockholm Län. Vi har fokuserat på hur provtagning och provtagningsresultatet påverkar sexuellt risktagande och därefter följande provtagningsepisoder. Vidare utvecklades en mobiltelefonibaserad intervention i syfte att förbättra sexuell hälsa och öka kondomanvändning bland ungdomar. Denna intervention har utvärderats i en randomiserad kontrollerad studie.

9.3 RESULTAT

9.3.1 Delstudie I

Registerbaserad studie på laboratorieresultat. Under en treårsperiod utfördes 119 699 klamydiaprover på 65 951 ungdomar på ungdomsmottagningarna i Stockholm Län. Totalt 7.9% av alla prov var positiva och 42 % av alla ungdomar upprepade provtagningen (mellan 2-18

provtagningar) under studietiden. Mer än två tredjedelar av studiedeltagarna var kvinnor. Bland de som upprepade provtagningen fann vi höga klamydiasiffror både vid den första och de följande provtagningarna. De kvinnor som testat positivt vid första provtagningstillfället återkom i större utsträckning och med kortare tidsintervall än övriga grupper. Kvinnor som testat negativt återkom i större utsträckning än män som testat positivt vid första provtagningstillfället.

9.3.2 Delstudie II

Kvalitativ intervjustudie som syftade till att utforska (1) vad som motiverar ungdomar att testa sig vid upprepade tillfällen samt (2) att förstå hur provtagningen påverkar sexuellt risktagandet. Vi fann att ungdomar inte upplever klamydia som en allvarlig sjukdom och att provtagning uppfattas som ett skydd som går att jämställa med att använda kondom. Varken provtagningen, provtagningsresultatet eller mötet med personalen på ungdomsmottagningen påverkade ungdomar att skydda sig mer. Upprepade negativa provtagningsresultat visade sig leda till ett ökat risktagande i relation till sex och kondomanvändning. Den största faran med klamydia beskrev ungdomar vara relaterat till att risken att smitta någon annan vilket kunde leda till ”dåligt rykte”. För att minimera risken att sprida smittan, uppfattades provtagningen som en god möjlighet att försäkra sig om att man är ”fräsch” och ”ren”.

9.3.3 Delstudie III

Kvalitativ intervjustudie med personal på ungdomsmottagningarna. Vi undersökte deras syn på provtagning, sexuell hälsa bland ungdomar samt preventivt arbete. Personal som intervjuades visade sig vara medvetna om att upprepad provtagning ibland användes istället för kondom. Dock uttryckte man att tillgänglighet till mottagningarna samt provtagning var en förutsättning för att kunna välkomna, möta och nå ungdomar i ett preventivt syfte. Vidare såg man det preventiva arbetet som en fortlöpande och ibland långvarig process som kräver tid och närvaro i varje möte. Flera uttryckte en frustration över de korta besök som erbjuds på drop-in mottagningarna. Att genom reflektion och samtal med ungdomar hitta en balans mellan sekundär prevention (provtagning och behandling) och primär prevention (främja kondomanvändning) ansågs viktigt.

9.3.4 Delstudie IV

Randomiserad kontrollerad studie (RCT). Individuella intervjuer, samt fokusgrupper med ungdomar gav underlag för att utveckla en mobiltelefonibaserad intervention (applikation - app) med syfte att främja sexuell hälsa och att öka kondomanvändning. En app till en "smarttelefon" utvecklades och utvärderades i en randomiserade studie ("The MOSEXY trial" - MObile Phone intervention for SEXual health in Youth). En mobiltelefonibaserad intervention för sexuell hälsa har inte tidigare testats i Sverige. Vi inkluderade 433 ungdomar som under det förgående halvåret haft ≥ 2 olika sexpartners. Hälften av ungdomarna fick tillgång till appen och andra hälften fick inte tillgång. Både grupperna svarade på frågor vid 3 olika tillfällen. Vi fann låg kondomanvändning i båda grupper vid studiestarten. Endast 1 av 10 uppgav att de varit helt skyddade med kondom under det senaste halvåret. Då studien avslutades hade kondomanvändningen gått upp något i båda grupperna men det var ingen skillnad mellan gruppen som fått tillgång till interventionen och den grupp som endast haft tillgång till vanlig vård. Studietiden varade 6 månader, 20 % fick under denna tidsperiod en sexuellt överförbar infektion och 70 % lämnade prov för en sexuellt överförbar infektion.

9.4 SLUTSATSER

Bland ungdomar som besöker ungdomsmottagningarna för klamydiaprovtagning så förekom upprepad provtagning bland en stor andel ungdomar. Tillgängligheten till provtagning uppskattades av ungdomar, dock ledde inte provtagningen, resultatet eller kontakten med personalen på ungdomsmottagningen till en minskning av sexuellt riskbeteende. Personal på ungdomsmottagningen uttryckte att tillgängligheten är viktig och en förutsättning för preventivt arbete med ungdomar. Dock måste tid finnas för samtal och reflektion kring sexuell hälsa, annars riskerar tillgänglighet till provtagning att inte ha önskad effekt. Enkel och snabb tillgänglighet till provtagningsservice är en viktig komponent för att förhindra spridning av sexuellt överförbara infektioner. Det är dock viktigt att sekundära preventiva insatser så som provtagning, inte tar fokus från primära preventiva åtgärder som syftar till ökad kondomanvändning.

I ett försök att stärka de preventiva åtgärderna med en smarttelefon-app fann vi att denna inte ökade kondomanvändningen bland ungdomar. Även om denna app inte hade någon effekt på kondomanvändningen, så finns potential för en sådan intervention att nå stora delar av

ungdomsgruppen/er. Utbrett sexuellt risktagande bland dessa ungdomar vittnar om ett stort behov av att stärka preventionsarbetet ytterligare.

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APPENDENCICIES

I: INTERVIEW GUIDE STUDY II

II: INTERVIEW GUIDE STUDY III

III: "FOR THE YOUNG, BY THE YOUNG"

IV: QUESTIONNAIRES, STUDY IV

APPENDIX I: INTERVIEW GUIDE STUDY II

Aspects to explore	**Questions**
Introductory questions	Tell me a little bit about yourself. Explore age, school, work, and family.
Using the clinic	Tell me about your experiences of visiting the clinic. What is the most common reason you come here?
Testing for Chlamydia	Vignette: *20 year old Alice had had a positive Chlamydia test about 3 months ago. She was upset when she got the test result and her ambition was to change her risky sexual behaviour by using a condom and having fewer sexual partners. When she comes to the clinic again she has had 3 new partners in the last 3 months since her infection. She used a condom with the first partner but with the next two she had no protection.* What do you think about that? How do you think that happens? Can you tell me about your experiences being tested for Chlamydia? What do you think about / know about Chlamydia?
Sexual risk-taking	What do you consider being a risky sexual behaviour? What do you consider having a safe sexual life is? Alcohol? Multiple partners? Emotional risk?
Aspects influencing repeated testing	Can you tell me a little bit more about being tested repeatedly for Chlamydia? What do you think influences young people to test repeatedly for Chlamydia? What happens when you get a test? What about condom use and repeated testing? What about other contraceptives and repeated testing? Trust in partner? What do you think about that? Does the fact that testing is free matter? Security for HIV Security for Chlamydia What would happen if people would start to pay for it?
Security in repeated testing	Tell me about how you feel when the test result is negative? How does the negative test result influence you? If you would test positive for Chlamydia how would that make you feel? Would a positive result influence you in any way?

APPENDIX II: INTERVIEW GUIDE STUDY III

Aspects to explore	**Questions**
Introductory questions	Tell me a little bit about yourself. Explore age, working experience.
Working at the Clinic	Tell me about your experiences of working the clinic. What do you appreciate with the Youth Health Clinic? What is difficult / challenging?
Sexual risk-taking	What do you consider being a risky sexual behaviour among youth? What do you consider having a safe sexual life is? Alcohol? Drug use? Multiple partners? Emotional aspects?
Testing for Chlamydia	Vignette: *20 year old Alice had had a positive Chlamydia test about 3 months ago. She was upset when she got the test result and her ambition was to change her risky sexual behaviour by using a condom and having fewer sexual partners. When she comes to the clinic again she has had 3 new partners in the last 3 months since her infection. She used a condom with the first partner but with the next two she had no protection.* What do you think about that? How do you think that happens? What do you think influences young people to test repeatedly for Chlamydia? Are there any risky behaviour that influences that? How so?
Aspects influencing repeated testing	What about condom use and repeat testing? What about other contraceptives and repeat testing? Trust in partner? What do you think about that? Does the fact that testing is free matter? What would happen if people would start to pay for it? Youth perception of HIV risk Youth perception of STI risk
Security in repeated testing	Tell me about the reactions to a negative test result. According to you, how does the negative test result influence subsequent sexual behaviour? Tell me about the reactions to a positive test result. According to you, how does the positive test result influence subsequent sexual behaviour? Social stigma in contracting STI / Infecting someone else. Gender perspective.
Primary prevention strategies	How would you like to work with sexual health promotion? How can we / can we affect condom use among youth?

APPENDIX III: For the young, by the young - Development of a smart phone application to promote safe sex practice among youth in Stockholm, Sweden

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Keywords:

mHealth; youth; smart phone application; sexual health; condom use; Sweden.

Introduction

Mobile health (mHealth), using mobile devices to address health priorities, has shown to be effective in increasing sexual health among youth such as increased knowledge regarding sexual health, increased testing for Sexually Transmitted Infections (STI), and condom use [1,2]. Up to date, evaluations mostly refers to interventions delivered via computer, e-mail, and text messages [1,2]. The possibility to download applications (apps) on mobile devices has opened up opportunities to develop and distribute health promotion interventions [3]. Health promotion via apps is suitable for youth, a tech savvy population who spend a significant period of time on their mobile phones. Additionally, the coverage of mobile phone ownership is high, 98% of the whole Swedish population own a mobile phone and 92% of these are smart phones [4]. In order to attract young users, and get youth to engage with an app on sexual health, it is important to involve youth in the development of the app [5].

Theoretical framework - the Trans-Theoretical Model and the Integrated Behavioral Model: In developing the smart phone app to increase sexual health and condom use among youth, we used two different models of behavioral change. The Trans-Theoretical Model (TTM), a model that conceptualizes the process of intentional behavior change and includes different stages of change [6]. These stages are: *Precontemplation* - not ready for a change; *Contemplation* - getting ready for a change; *Preparation* – intends to take action within foreseeable future and has taken some behavioral steps in this direction; *Action* – Changed behavior; *Maintenance* – adhere to the new behavior. The Integrated Behavioral Model (IBM) contains five components affecting behavior [7]: *Behavioral intention* (determined by attitudes, perceived norms, and personal agency); *Knowledge and skills* to carry out the behavior; *Importance to the individual*; *Environmental constraints* that make behavioral performance difficult; *Habit* (experience performing the behavior, the behavior will become habitual).

Objectives

The objectives of this study was to explore with youth and obtain their input on the content of a smart phone application to promote safe sex. The ideas from the youth were to be incorporated subsequently in an application to be tested in the context of the Youth Health Clinics in Stockholm County.

Methods

Setting: This study was conducted at the Youth Health Clinics (YHCs) in Stockholm County, Sweden (250 clinics in the whole country, 33 in Stockholm County) [8,9].

Participant selection: We conducted 15 individual in depth interviews with youth at the YHC, and two focus group discussions (FDGs). Interviewed participants were selected purposefully using heterogeneous sampling [10] so that youth from different socio-economic areas were represented. For the FGD, youth attending one YHC as clients, and were invited to participate.

Data collection: Interviews with youth aged 18-22 were performed from April 2015 to April 2016 (7 males, 8 females). The FGDs were held in October and November 2016. The first FGD had 4 female

participants, while the second included 3 females and 2 males. Interviews with youth were performed by the first author (AN) in Swedish. They were recorded and transcribed verbatim. The FGDs, supported by three members of the research team, were recorded, notes were taken, and a summary of notes and the recordings were made.

Areas explored: The questions posed in the interviews and in the workshops were; *Why do you think condom use is low among Swedish youth? What is positive with condom use? What do you think about mobile phones to reach young people with health messages? Could a smart phone app work to mediate safe sexual practices? What would such an app contain? How could the app be made attractive to youth? Mode and timing of push-notices (message/reminders to engage in activities) in the app?*

Data analysis: The recordings and transcripts were listened/read through on several occasions. Categories emerged from the data as a result of parallel analysis and mutual in-depth discussions between researchers.

Ethical considerations: Written informed consent was obtained from each participant. The study was approved by the Stockholm Regional Ethical board (reference number 2013/1399-31/2, with amendment 2015/739-32).

Results

The smart phone app (subsequently named "*Skyddslaget*" or *'Protection team'*) was developed based on the categories that emerged from the data from interviews and FGD. These categories were embedded into the app content, mode, and tone while being guided by the TTM and IBM frameworks. Suggestions for the content, mode, and tone of the app are summarized in Table 1. With regard to content, youth requested sexual education, including STI information. Additionally condom specific information including practical usage technique, advises on how to have "the condom talk", and decrease shame related to condom use were requested. Youth suggested different modes to deliver the

content including text messages, movie clips, and push-notices. The tone of the messages delivered, youth suggested, should be fun and entertaining and supportive (Table 1).

Table 1: Requests from youth, regarding the content, mode, and tone of the app.

Content	**Mode**	**Tone**
Information regarding STI	Games	Fun and entertaining
Sexual education	Week-end condom reminders	Supportive
Condom-information	Movie clip	Containing pep-talk
Increase self-confidence related to condom use	Imagery (emojis)	Allowing
Condom technique	Text (not heavy)	Scaring (the "light-version")
Preparation for the condom talk	Quiz	Identifying with peers
Decrease shame and stigma related to condom use	Push-notices	Encouraging
Alcohol and unsafe sex	Adding new information to keep interest	
Questioning norms (sex with condom is not good)	Interactive	
Normalizing condoms		

The inputs from Table 1 were sorted into different groupings that were each reflected in one of the nine focus areas of the application during the subsequent phase of app development. These were: *Condom obstacles and solutions; Quiz; Games; Self-refection; Challenges; "Others tell" (peers tell their story, the doctor informs); Condom tip, Pep-talk and bosting; and Random facts.* Thus, the focus areas emerged both from the content, mode, and tone requested.

App material for the different focus areas was developed relative to the different stages of change in the TTM, where each stage lasted for 30 days, supporting youth to move from one stages to the next. Content was added into the app on a daily basis for 180 days, the time period for which the intervention lasted. The self-reflecting and pedagogic tasks in the app were based on the IBM. These tasks addressed feelings, thoughts, experiences, attitudes, and perceived self-control in relation to condom use and

unprotected sex, and were mainly found under the categories *"Condom obstacles and solutions"* and *"Self-reflection"*.

The informative part of the app (i.e. sexual education, information about STIs) was mainly presented under the focus-area *"Others tell" (the doctor informs)* and *"Random facts* ". Additionally *"Random facts"* also contained curiosities related to sex and sexuality. The app was therefore designed also to sustain the interest of the youth over a few months. The interactive actions under the other focus areas including *Quiz, Games,* and *Challenges* were also intended to sustain engagement. Identification with peers was strongly suggested by youth and was included in the *"Others tell" (peers tell their story),* this aimed to create a sense of identification and thereby eliminate possible feelings of shame related to a behavior. "*Others tell"*, contained information mediated by movies and sound-clips. The encouraging tone was notable throughout the intervention, and mainly found under the category *"Pep-talk and boosting"*. The aim was to support the target group in their behavior changing process. Each day of the intervention at least one condom tip was posted (under the category *"Condom tip"*). The aim was to inform about different condom types and sizes, and normalizing condoms by daily exposure. Additionally push-notices were used to capture the attention of the youth that new content had been added into the app, and also each Friday evening, a condom reminder push-notice was sent out to participants.

The team that developed the app had varied backgrounds including YHC staff working with youth (midwife), public health, medicine, information technology and behavioral science. The function and content of the app was initially piloted among ten users.

Discussion

We used the data from FGD and individual interviews with youth belonging to the target group to develop the content, mode, and tone of a smart phone app to promote safe sex. Inputs from youth were embedded into existing frameworks previously proved successful (TTM and IBM) [11]. To use input from youth is important as the success of the intervention largely depends on the level of

engagement and usage by youth. mHealth interventions are particularly suitable for youth and sexual health promotion as the intervention is delivered in a familiar, and discrete way to at-risk population [12]. Analysis from the MOSEXY-Trial (MObile phone for SEXual health in youth) where the *"Skyddslaget"* app was subsequently evaluated in a pragmatic randomized controlled trial and will be reported separately [13].

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APPENDIX IV: QUESTIONNAIRES STUDY IV

Bakgrundsinformation frågeformulär vid inkludering som besvaras i applikationen
Hej. Första frågeformuläret består av 27 frågor med olika svarsalternativ. Dina ärliga åsikter och svar är viktiga. Vi lägger inga moraliska värderingar i hur du svarar på frågorna. Din identitet är helt skyddad.

1. **Jag är**
    - **man**
    - **kvinna**
    - **vill ej definiera**

2. **Hur gammal är du?**
    - **18**
    - **19**
    - **20**
    - **21**
    - **22**
    - **23**

3. **Högsta avslutade/pågående utbildning?**
    - **Grundskolan**
    - **Gymnasiet**
    - **Högskola/Universitet**

4. **Sysselsättning**
    - **studerar**
    - **arbetar**
    - **arbetssökande**
    - **arbetar och studerar**

5. **Boendesituation**
    - **bor hemma med föräldrar/förälder**
    - **har flyttat hemifrån**

6. **Vad stämmer bäst in på hur du lever just nu**
    - **Singel**
    - **Fast relation**
    - **Dejtar en person men har inte en fast relation**
    - **Dejtar två eller flera men har inte en fast relation**
    - **Har en återkommande sexpartner**
    - **Har flera återkommande sexpartners**

7. **Har du under de senaste 6 månaderna haft en pågående sexuell relation med en person som under samma period haft sex med någon annan än dig?**
    - **Nej**
    - **Nej, jag tror inte det**
    - **Ja**
    - **Ja, det tror jag**
    - **Jag har ingen sexpartner**

8. **Hur gammal var du när du hade samlag (vaginalt och/eller analt) första gången?**

9. **Med hur många partners totalt har du har du haft samlag (vaginal och/eller analt) i hela ditt liv? Uppskatta om du inte minns exakt**

10. **Om du tänker på den/dem du har haft samlag med under de senaste 6 månaderna, vem/vilka har det varit?**

    - **Endast kvinnor**
    - **Endast män**
    - **Oftast kvinnor, ibland män**
    - **Oftast män, ibland kvinnor**
    - **Någon/några som varken uppfattar sig som man eller kvinna**

11. **Med hur många partners totalt har du haft samlag (vaginalt och/eller analt) de senaste 6 månaderna? Uppskatta om du inte minns exakt.**

    - **0**
    - **1**
    - **2**
    - **3**
    - **4**
    - **5**
    - **6**
    - **7**
    - **8**
    - **9**
    - **10 eller fler**

12. **Med hur många personer har du haft *skyddat* samlag (vaginalt och/eller analt) de senaste 6 månaderna? Med skyddat menas samlag *med* kondom varje gång och under *hela* samlaget.**
    - **0**
    - **1**
    - **2**
    - **3**
    - **4**
    - **5**
    - **6**
    - **7**
    - **8**
    - **9**
    - **10 eller fler**

13. **Använde du kondom vid senaste samlaget (vaginalt och/eller analt)?**

    - **Ja**
    - **Nej**
    - **Kommer inte ihåg**

14. **Hur ser din typiska kondomanvändning ut**

    - **Aldrig**
    - **Sällan**

- **Ungefär varannan gång**
- **Oftast**
- **Alltid**

15. **Använder du något preventivmedel förutom kondom (p-stav, spiral, p-ring, p-piller, minipiller, annat)?**

    - **Ja**
    - **Nej**

16. **Har du någon gång i livet haft en könssjukdom (klamydia, gonorré, mycoplasma, herpes, kondylom, annat)?**

    - **ja**
    - **nej**
    - **vet inte/har aldrig testat mig**

17. **Hur ofta brukar du lämna prov för könssjukdomar?**

    - **Jag har aldrig testat mig**
    - **Jag testar mig ungefär en gång per år**
    - **Jag testar mig 2-3 gånger per år**
    - **Jag testar mig 4-5 gånger per år**
    - **Jag testar mig efter varje gång jag har haft oskyddat samlag**

18. **Har du varit gravid eller gjort någon gravid?**

    - **ja**
    - **nej**
    - **vet inte**

19. **Har du någon gång under de senaste 6 månaderna haft sex med någon som du egentligen inte ville ha sex med?**

    - **Nej**
    - **Ja**
    - **Vill inte svara på frågan**

20. **Har du någon gång under de senaste 6 månaderna ställt upp på någon typ av sex som du egentligen inte ville ha eller efteråt ångrat att du ställde upp på?**

    - **Ja**
    - **Nej**
    - **Vill inte svara på frågan**

21. **Har du någon gång under de senaste 6 månaderna haft sex med någon första gången ni träffades?**

    - **Nej**
    - **Ja, 1 gång**
    - **Ja, 2 gånger**
    - **Ja, 3 gånger**
    - **Ja, 4 gånger**
    - **Ja, 5 gånger**
    - **Ja, 6 gånger eller fler**

22. **Har du någon gång under de senaste 6 månaderna haft oskyddat samlag (vaginalt och/eller analt) med någon första gången ni träffades?**

    - **Nej**
    - **Ja, 1 gång**
    - **Ja, 2 gånger**
    - **Ja, 3 gånger**
    - **Ja, 4 gånger**
    - **Ja, 5 gånger**
    - **Ja, 6 gånger eller fler**

23. **Hur ofta har du under de senaste 6 månaderna varit påverkad av alkohol eller andra droger när du har haft sex med en tillfällig partner?**

    - **Aldrig**
    - **Sällan**
    - **Ungefär varannan gång**
    - **Oftast**
    - **Alltid**
    - **Jag har inte haft sex med en tillfällig partner de senaste 6 månaderna**

24. **När jag har sex med andra klarar jag alltid av att bestämma över vilken typ av sex jag själv vill ha**

    - **ja alltid**
    - **ja oftast**
    - **Ungefär hälften av gångerna**
    - **sällan**
    - **aldrig**

25. **Vilken typ av sex jag har med en annan person bestäms mer av den andra personen än av mig?**

    - **ja alltid**
    - **ja oftast**
    - **Varken eller**
    - **sällan**
    - **aldrig**

26. **Jag är bekymrad över hur jag blir bedömd som sexpartner?**

    - **Instämmer helt**
    - **Instämmer delvis**
    - **Varken eller**
    - **Instämmer inte alls**

27. **Om jag har en ny eller tillfällig relation och vill att vi använder kondom som skydd så har jag mod att be om det?**

    - **Ja, alltid**
    - **Oftast**
    - **Sällan**
    - **Nej, aldrig**

Frågeformulär som skickas ut efter 3 månader/ 6 månader
Introduktionstext: *Hej igen. Dessa 19 frågor syftar till den tid som har gått sedan du senast svarare på frågor i "appen", alltså då studien startade för 3 månader sedan. Dina ärliga åsikter och svar är viktiga. Vi lägger inga moraliska värderingar i hur du svarar på frågorna. Din identitet är helt skyddad.*

1. **Vad stämmer bäst in på hur du lever just nu**
    - **Singel**
    - **Fast relation**
    - **Dejtar en person men har inte en fast relation**
    - **Dejtar två eller flera men har inte en fast relation**
    - **Har en återkommande sexpartner**
    - **Har flera återkommande sexpartners**

2. **Har du under de senaste 3 månaderna haft en pågående sexuell relation med en person som under samma period haft sex med någon annan än dig?**
    - **Nej**
    - **Nej, jag tror inte det**
    - **Ja**
    - **Ja, det tror jag**
    - **Jag har ingen sexpartner**

3. **Om du tänker på den/dem du har haft samlag med under de senaste 3 månaderna, vem/vilka har det varit?**
    - **Endast kvinnor**
    - **Endast män**
    - **Oftast kvinnor, ibland män**
    - **Oftast män, ibland kvinnor**
    - **Någon/några som varken uppfattar sig som man eller kvinna**
    - **Jag har inte haft samlag under de senaste 3 månaderna**

4. **Med hur många partners totalt har du haft samlag (vaginalt och/eller analt) de senaste 3 månaderna? Uppskatta om du inte minns exakt.**
    - **0**
    - **1**
    - **2**
    - **3**
    - **4**
    - **5**
    - **6**
    - **7**
    - **8**
    - **9**
    - **10 eller fler**

5. **Med hur många personer har du haft skyddat samlag (vaginalt och/eller analt) de senaste 3 månaderna? Med skyddat menas samlag med kondom varje gång och under hela samlaget.**
    - **0**

- **1**
- **2**
- **3**
- **4**
- **5**
- **6**
- **7**
- **8**
- **9**
- **10 eller fler**

6. **Använde du kondom vid senaste samlaget (vaginalt och/eller analt)?**

   - **Ja**
   - **Nej**
   - **Kommer inte ihåg**

7. **Använder du något preventivmedel förutom kondom (p-stav, spiral, p-ring, p-piller, minipiller, annat)?**

   - **Ja**
   - **Nej**

8. **Har du någon gång under de senaste 3 månaderna haft en könssjukdom (klamydia, gonorré, mycoplasma, herpes, kondylom, annat)?**

   - **ja**
   - **nej**
   - **Vet inte/har inte testat mig**

9. **Har du under de senaste 3 månaderna testat dig för könssjukdomar?**

   - **Ja en gång**
   - **Ja flera gånger**
   - **Nej**
   - **Jag kommer inte ihåg**

10. **Har du de senaste 3 månaderna varit gravid eller gjort någon gravid?**

    - **ja**
    - **nej**
    - **vet inte**

11. **Har du någon gång under de senaste 3 månaderna haft sex med någon som du egentligen inte ville ha sex med?**

    - **Nej**
    - **Ja**
    - **Vill inte svara på frågan**

12. **Har du någon gång under de senaste 3 månaderna ställt upp på någon typ av sex som du egentligen inte ville ha eller efteråt ångrat att du ställde upp på?**

    - **Ja**

- **Nej**
- **Vill inte svara på frågan**

13. **Har du någon gång under de senaste 3 månaderna haft sex med någon första gången ni träffades?**

    - **Nej**
    - **Ja, 1 gång**
    - **Ja, 2 gånger**
    - **Ja, 3 gånger**
    - **Ja, 4 gånger**
    - **Ja, 5 gånger**
    - **Ja, 6 gånger eller fler**

14. **Har du någon gång under de senaste 3 månaderna haft oskyddat samlag (vaginalt och/eller analt) med någon första gången ni träffades?**

    - **Nej**
    - **Ja, 1 gång**
    - **Ja, 2 gånger**
    - **Ja, 3 gånger**
    - **Ja, 4 gånger**
    - **Ja, 5 gånger**
    - **Ja, 6 gånger eller fler**

15. **Hur ofta har du under de senaste 3 månaderna varit påverkad av alkohol eller andra droger när du har haft sex med en tillfällig partner?**

    - **Aldrig**
    - **Sällan**
    - **Ungefär varannan gång**
    - **Oftast**
    - **Alltid**
    - **Jag har inte haft sex med en tillfällig partner de senaste 3 månaderna**

16. **När jag har sex med andra klarar jag av att bestämma över vilken typ av sex jag själv vill ha?**

    - **ja alltid**
    - **ja oftast**
    - **Ungefär hälften av gångerna**
    - **sällan**
    - **aldrig**

17. **Vilken typ av sex jag har med en annan person bestäms mer av den andra personen än av mig?**

    - **ja alltid**
    - **ja oftast**
    - **Varken eller**
    - **sällan**
    - **aldrig**

18. **Jag är bekymrad över hur jag blir bedömd som sexpartner?**

- **Instämmer helt**
- **Instämmer delvis**
- **Varken eller**
- **Instämmer inte alls**

19. **Om jag har en ny eller tillfällig relation och vill att vi använder kondom som skydd så har jag mod att be om det?**

    - **Ja, alltid**
    - **Oftast**
    - **Sällan**
    - **Nej, aldrig**